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☞ An asterisk (*) denotes an illustrated article

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SIXTH ANNUAL MEETING OF THE AMER. GAS-LIGHT ASSOCIATION.

OFFICE OF AMERICAN GAS-LIGHT ASSOCIATION,
150 BROADWAY, N. Y. CITY.

To the Gas-Light Companies of America, and the private individuals engaged in the manufacture of Illuminating Gas:

Permit me to present some reasons showing, or tending to show, why each and every manufacturer of gas for lighting purposes, should take an active interest in the Association for the protection and advancement of his investment in that manufacture.

The use of gas, for lighting purposes, by a public community, dates back only about seventy years, it being first used in the city of London, in the year 1814. From that time, until the discovery of petroleum in 1859, no source of illumination was known to the world which, taken light for light, could begin to compare with gas in price. Neither was petroleum produced in sufficient quantities to seriously interfere with the sales of gas, until about the year 1872 or 1873. The bringing upon the markets of the world, for light, of an article sold cheap, and producing undeniably a good light, has developed in petroleum the strongest competitor that gas has ever had to compete with. The financial and business depressions of our country, and of other commercial countries, since 1873, have had a strongly-marked effect in making petroleum a rival of gas for use as light by the public, on account of its less cost and the poverty of the public.

There can be no reasonable doubt but what petroleum will continue to be produced in quantities sufficient to keep the same at a low price for many years to come. Pennsylvania has been, up to this time, the great source of supply for all countries and peoples using it. Even the Pennsylvania oil field has been much extended within the past two years; other oil-fields have been found in Canada and in West Virginia, Kentucky, California, and other states of our country. In Italy and Russia, and in Russia especially, oil-fields have been found whose records run back of historic times, so large in extent, and productive in quality as to at once become formidable rivals of the Pennsylvania fields when the means of transport shall have been provided.

The geologic conditions under which petroleum is found ensures, to a certainty, that it will continue to be found, in new places and new countries, when sought for.

A new rival for gas (the electric light) is now looming up in the distant horizon, and has already become more than a small cloud in the distant view. It is conceded, even by gas manufacturers, that for lighting large spaces, where no particular nicety of light is required, the "electric light answers the purpose well. Greater influence also appears in the distance, so far as the gas makers of this country are concerned—that is, the great, strong, and prevailing tendency in England, Scotland, and Ireland, also felt in France and Germany, that the gas companies shall make a gas of high candle power, most thoroughly purified, and for a low price, with a yet constant demand from their consumers, sustained by legislative enactment and common council regulation, compelling lower and still lower prices—the lowest depth not yet reached.

The same influences which have compelled the European gas manufacturers to improve the quality, and at the same time to sell at lower and still lower prices, begin to be felt in the larger cities of America, sufficiently so to be already causes of anxiety. One form of it taking the shape of establishing competing gas companies, with aid and encouragement from the local community where such company is sought to be established, as a punishment to the old company for not giving them what they might or ought to have done either in quality or price.

Now, how shall the present gas makers of America best meet the competition and dangers which so cloud, and perhaps threaten, the sky of the future.

On the prairies of the West the hunters are said to fight fire with fire, so the gas makers of today must fight the battle of light by light—low in price and good in quality.

How shall, or can they, make gas better and cheaper? I answer—by becoming better qualified for the business; by obtaining a more perfect knowledge of the laws of nature essentially involved in that manufacture, such as Geology, Chemistry, Combustion to make heat, and of Heat, its conduction and radiation. All these occur in the manufacture and purification of gas. Then comes the knowledge of how to burn it so that its full value may be obtained.

How and where can this knowledge be the most quickly, cheaply, and beneficially learned? I answer—in and through the Gas-Light Association; by a personal participation in its meetings, and an association with the members at their annual gathering. The private converse and interchange of thoughts and experiences being quite as valuable as the public meetings. If not able

to be present, then by membership, for its moral effect, and by a contribution of cash, to enable the Association to make investigations by the united contributions of its members, where no one private person would undertake the same; also, to enable the Association to print the thoughts and productions of its members, so that a permanent record of the same may be made for future use—each one for himself at his own works or fireside. To sum up the advantages of the Association, in short; each member gets the benefit of the united contributions of all the members, in thought, study, and cash, in return for his own —one hundred and fifty per cent.! Have I not shown that each and all can afford to become members of the American Gas-Light Association?

CHARLES NETTLETON,
Secretary.

THE WESTERN GAS MANAGERS ASSOCIATION.

We are requested to give notice to the gas managers and engineers of the Western states, that hey are invited to attend a meeting, which is to be held in St. Louis, Mo., on the 18th and 19th of September, for the purpose of organizing "The Western Gas Managers Association." Full particulars will be found on another page of this issue.

As the National and New England Associations have already produced most excellent results, we advise all our western friends to attend the meeting, and become members, or else they may not be able to hold their own in these days of sharp competition.

THE ELECTRIC LIGHT.

We have taken from the New York *World* a very interesting report, by Prof. B. Silliman, on the Electric Light as used in Paris for illumination, which contains a great deal of useful information on the subject.

It is claimed that one Jablochkoff candle is equal in power to about 100 of the ordinary gas-lights, when the illuminating power of each equals 15 candles, and the consumption of gas 5 cubic feet per hour: and that the cost of the said gas-lights is double that of the Jablochkoff candle.

That the illuminating power of one Jablochkoff candle is equal to that of about $100 \times 15 = 1{,}500$ sperm candles; and that 100 of the said gas lights consume about $100 \times 5 = 500$ cubic feet of 15 candle gas per hour.

That one Jablochkoff candle requires a machine of one horse-power to run it.

It also appears that great difficulties have yet to be overcome in the subdivision of the circuit, and that the Northern Railway station in Paris, which was illuminated by the electric light, has returned to gas, and the gas company claims that electricity cannot compete with the ordinary gas.

We think that the inventors of the Jablochkoff candle and machines have sadly overrated the illuminating power and value of the light.

The method which they adopted for comparing the gas and electric light with each other would produce results that would be tremendously in favor of the electric light.

If they wish to make a fair comparison let them unite the 100 gas-lights into *one*, which shall have a perfect combustion, and compare this *concentrated* light with the Jablochkoff candle; or else let them divide the Jablochkoff candle and power up into 100 smaller lights, and compare it with the 100 gas-lights, then they will see the fallacy of their claims.

The Jablochkoff candle transmits its waves of light from one point or common origin; consequently, the waves will not interfere with each other, and a great wave, and a strong light, will be produced.

The gas-light, with which they compared the electric light, was divided up into 100 small lights, which transmitted waves of light from 100 different points of origin; consequently, the waves of light interfered with each other, and a weak wave and a dim light would be produced.

The results will be precisely the same when they compare the electric light with one ordinary gas-light, and then calculate the illuminating power of the former by simple ratio.

We claim that a consumption of 500 cubic feet per hour, of a gas which will give 15 candle power, at five cubic feet consumption per hour, will give—

$$\frac{500^2 \times 15}{5^2} =$$

150,000 candle power, when concentrated, and the combustion perfect!

Hence, if one electric light were equal in power to 1500 candles, as claimed when the gas light is divided up into 100 small lights, then the concentrated gas light will be equal in intensity to—

$$\frac{150{,}000}{1500} =$$

100 of the Jablochkoff candles!!

According to this law, we find that a burner consuming 50 cubic feet of 15 candle gas per hour, will give an illuminating power equal to 1500 candles, or one Jablochkoff candle if the combustion of the gas be perfect.

Major Elliot, in his Report on the "European Light House System," says that the illuminating power of a Wigham gas burner, when consuming 290 cubic feet of gas per hour, is equal to 2,577·3 sperm candles—when unassisted with lenses. Hence, this burner, though far from being perfect, gives a much better result, with a consumption of only 290 cubic feet, than that obtained from the 100 ordinary gas-lights, or one Jablochkoff candle.

We will now give a few of the fundamental laws relating to light and wave motion, which have been generally accepted by the most prominent scientists of the present time.

1. According to the undulatory theory light is propagated through a very elastic luminiferous ether, which fills all bodies as well as the whole universe.

2. The vibrating molecules of all luminous bodies are communicated to this elastic ether, and are carried off in the shape of waves in every direction.

3. Every substance which sets this ether in motion is luminous. A luminary which gives an intense light will produce strong vibrations, or waves of great amplitude; and a luminary which gives a dim light, weak vibrations, or waves of low amplitude.

4. The amplitude, or height, of these vibrations, or wave motions, when measured from furrow to crest, depends altogether upon the power or intensity of the luminary.

5. The intensity of any luminary is as the square of the *amplitude, or height*, of the wave which it generates.

6. The intensity of light is inversely as the square of the distance from the luminary.

7. When two *equal* series of light, or water waves, start at the same time, from *one point*, and run together so that crest shall coincide with crest, and furrow with furrow, then the amplitude, or height, of the wave motion, will be *double* the height of either singly.

8. When two *unequal* series of light, or water waves, start from *two points*, and run together, they will *interfere* with each other, so that the light waves will produce darkness, and the water waves still water.

9. The principle of interference applies to sound, water, and light.

10. If two sounds of the same intensity coincide, one with the other, a sound will be produced of *four times* the intensity of either singly.

We will now add a few more facts which we have deduced from the above.

The intensity of a luminary, when the combustion is perfect, is as the *square* of the volume of gas consumed, and not in direct ratio, as is generally supposed.

When two flames, or luminaries of equal intensity, are united together all the light waves will then start from one point or common origin, and run together, so that crest will coincide with crest and furrow with furrow, and the amplitude, or height, of the wave will be *double* the height of that produced from either of the single luminaries (see clause 7), and the intensity of the light will be *four times* that of either singly (see clause 5.)

When two luminaries are placed apart, a portion of the waves from each will interfere; or, in other words, will come in collision one with the other. The crests of the one series will fall on the furrows of the other, and darkness will be produced. (See clause 8.)

It is this principle of interference that makes it utterly impossible for a number of independent luminaries to give the same illuminating power as they will when united and concentrated, and the waves of light are thrown out from one point or common origin.

Most likely we shall never be able to obtain the theoretical value, but we ought to reach a point much nearer to that value than we have yet done, by devising a more suitable and perfect burner for large consumptions of gas.

An admirable opportunity is certainly open for some of our enterprising inventors to get up a series of burners which will consume a reasonable amount of gas, and produce a light in accordance with the law of squares, or as near it as possible.

Prof. Tyndall found that when a candle was taken up into an exceedingly high mountain, that it did not give the same illuminating power as it did at the foot, although it consumed the same weight of sperm in both places.

It is also found that when a light is taken under water, in a box or diving-bell, that it will give a much greater illuminating power than that obtained from it when above the water.

This indicates that a very large volume of gas may be consumed in an ordinary burner, by bringing sufficient pressure down on the flame.

Through ignorance of the laws relating to light inventors have not had the least conception of the brilliant light which may be obtained from the ordinary gas; and, consequently, they have been working in the *dark* in every sense of that word.

In conclusion, we beg to refer our readers to the following works which relate to this important subject, and from which we have drawn on for this article.

"Heat as a Mode of Motion," by Prof. Tyndall.
"Light and Electricity," " "
"On Sound," " "
"Wave Theory of Light," by H. Lloyd.
"The Nature of Light," by Eugene Lummel.
"Physics of Ether," by T. Preston.
"Familiar Lectures on Scientific Subjects," by Sir John Herschel.

Electric Lamps in Paris.

PROFESSOR SILLIMAN'S LETTER TO THE NEW YORK "WORLD."

We copy the following letter from Professor SILLIMAN describing, in popular language, the Electrical Illumination which is now so much spoken of in Paris. The letter was not written for the Gas Fraternity, but Prof. SILLINAN'S well known familiarity with the gas industry, at home and abroad, will commend his remarks to our readers.—ED.

PARIS, July 27.—All the world—meaning Paris and her guests—have seen the magnificent illumination by the electrical lamps of Jablochkoff, unless, indeed, they have been so blinded by excess of light that they have seen nothing. A walk up the Avenue de l'Opera, of a dark night, from the Palais Royal to the Grand Opera House, or in the Orangeries of the Garden of the Tuilieries, or along the shops of the Belle Jardinière, or by the Arc de l'Etoile, will dazzle the strongest eyes with the splendor and penetrating intensity of the great globes of opaline glass which temper the insufferable solar glare of the unprotected light. I never see these beautiful globes without being reminded of that familiar class-room experiment of the chemical laboratory when phosphorus is burned in a glass sphere filled with oxygen, and the critical point arrives when the whole glowing space is filled with the burning vapor of the volatilized phosphorus, and the blaze of glory for the moment seems above the brightness of the sun. So in these electrical lamps the same impression is made, save that the seconds of duration for the phosphorus are extended to hours for the electricity. Objects viewed by the electrical light are seen in their natural colors, and such is the effect of refraction and reflection in producing a general diffusion of light that no deep shadows are seen, as was the case when only a single focus of unblenched electrical light was employed. The lamps are set so high that there is no occasion to look *at* them, except the fascination of the thing, while yet the effect is a novelty. The whole street, to the tops of the loftiest houses, is ablaze with a flood of beaming light, which makes the streets seem like the scenes of some grand play at the opera.

Everybody says when this effect is first seen here, "Now is the dawn of a new era. Gramme and Jablochkoff are the real Promotheuses of mythology, and here is the heavenly radiance come down to earth. No more lurid gleams of murky gas to despoil our city treasuries and juggle the people with those thimble-rigging meters which nobody trusts! Farewell to coal and all the smutty and ill-smelling tribe of hydrocarbons! We have seized the heavenly radiance of Apollo with the thunderbolts of Jove, and can bid defiance to street mains and all the unsightly and unsavory concomitants of the gas-house." This is about the talk one hears, and naturally enough; but science teaches us to keep cool (even in these hot days!), and we are advised to investigate the subject calmly before we sell our gas stock or take up the shares of the "Société Général D'Electricité Anonyme." And what is the result? I cannot state it better than by quoting the words of M. Hyppolyte Fontaine, of Paris, the engineer of the Gramme company, and author of an elaborate volume on electrical illumination. Speaking at the last meeting of the London Institution of Mechanical Engineers, M. Fontaine says: "The electric light does not interfere with gas-light nor with oil light nor with candle-light. It will not revolutionize, as has often been averred, the question of lighting, destroying what is now in use, and monopolizing every industrial application, domestic and public. The electric light has its place marked out for it under many circumstances; but, far from diminishing the consumption of the other lights, it will lead to their further development by demonstrating the advantages of a more powerful and more complete illumination." These words, coming from one whose position would naturally prompt him rather to exalt his office, express the simple truth as we understand it to-day. The whole thing is in its infancy. We are dealing with a wonderful power which is as yet but imperfectly in our control, and we have very much to learn about it. How recent its industrial application is will be better seen if we remember that in 1874 there were only four applications of it to industrial uses; in 1875, 12; in 1876, 85; in 1877, 350, and at present there are upwards of 500 applications of the light—amounting in intensity to more than a million and a half of candles. This is not much compared with the total illumination, public and private, of this great city, but it is a great deal when it is considered how recently the new light made its appearance, and how many difficulties attend the introduction of all new inventions. By virtue of its remarkable space-penetrating power it is specially adapted for various purposes where illuminations previously known were quite inadequate. With the aid of a lenticular projector it acquires a prodigious power of reaching into space and distinguishing objects many miles distant. By the naked light, unaided, spacious halls or extensive yards may be lighted up so that by night as by day the movements of merchandise or manufacturing operations, on a large scale, or work in the open air, may be followed up; while by the use of ground or opaline glass, and by properly constructed reflecting ceilings, as in cotton spinning and other manufacturing establishments, a generally diffused and softened light may be obtained without sharp shadows, in which delicate operations may be as well conducted by night as by day.

Many questions are on the tongues of your readers, which I hope to answer before they are asked. For example: What is the source of this wonderful light? How is it produced and transmitted? What is its cost, as compared to gas, for example, for an equal intensity of illumination? What limits its production and economical application to human uses? And so on. It is important here clearly to indicate the distinction—which is a fundamental one—between the light of a Voltaic arc from a Voltaic battery excited in the usual way by the action of acids upon zinc, etc., and the electrical light we are now considering, and which is the result of magnetic induction, and is simply the dynamical equivalent of mechanical force, and depends not in any manner upon chemical action. Undoubtedly the earliest exhibitions of the electric light from the Voltaic battery were those made with the "deflagrators" of Dr. Hare, by Professor Silliman, at New Haven, in 1822, and subsequently on a magnificent scale in Boston, in 1836, when an arc of over five inches in diameter was produced by the simultaneous immersion of 900 large-sized couples of Hare's deflagrator. But no means had then been devised for the regulation of the electrical light to render it constant, and although the writer as early as 1842 used this light successfully to produce daguerreotypes, the progress of invention had yet to make further use of the discoveries of science before electrical illumination was possible. We need not follow now this branch of the subject further. Suffice it to say that the electrical light with which we are now concerned, uses no voltaic battery, consumes no acids or other chemical agents, is, in short, the author of its own existence, so to speak, being nothing more than the equivalent of a certain amount of motion—mechanical motion—converted into molecular motion, into heat and light through the medium of magnetism. Long did men grope in the dark seeking to grasp the hidden thread connecting the magnetic force with the other known modes of electrical manifestation. The oldest of the three sisters—

MAGNETISM, ELECTRICITY, VOLTAISM,

it waited the birth of the latter before Oersted could perform the simple experiment of the "conjunctive wire" and demonstrate, in 1819, the conversion of voltaism into magnetism (electro-magnetism), and for Sturgeon, of England, in 1826 to produce the first electro-magnet of soft iron by winding it with Oersted's conjunctive wire formed into a spiral—the "helix." And here the march of discovery halted until about 1830, when Henry showed us how to produce electro-magnets of a power not before dreamed of, and following up his discoveries simultaneously with Faraday, they, without comparison of notes, fell upon the fundamental facts of electro-magnetic induction and the phenomenon of secondary currents and the *extra* current with its splendid spark. At this moment, 1831, appears Joseph Saxton, of Philadelphia, who, being in London at the time, and acquainted alike with the researches of Hare, Henry, and Faraday, with his well-known mechanical skill, constructed the first magneto-electric machine, which, by revolving an armature of soft iron, wound with insulated copper-wire, before the poles of a permanent magnet, obtained a constant succession of brilliant sparks and powerful shocks. This apparatus of Mr. Saxton was pirated by a man named Clarke, of London, and curiously enough another person of the same name—also an Englishman—twenty years before, or more, appropriated without acknowledgment, the oxyhydrogen blow pipe of Dr. Hare!

Here, so far as electrical illumination is concerned, the matter rested for many years. Inventors had all the material facts before them then as now, but so intent were they upon converting to some practical use the enormous magnetic power developed in masses of soft iron by the voltaic current—a very natural direction in which to follow up the suggestion of Henry's discoveries—that the less promising field of developing light from magnetism without the intermediation of chemical agency was quite overlooked and neglected. It is needless to say that the effort to obtain any valuable effects from the conversion of magnetism into mechanical motion was necessarily a failure, and in the present state of science no one would be justified in spending a moment of time or a dollar of money upon such a scheme. But, given a definite source of mechanical force, required to evolve from it a certain equivalent of heat and light through the intervention of magnetism, and the problem offers entirely new features. Nay, more; mechanical is thus converted into chemical force, and the electro-deposition of metals is now conducted either by the water-wheel or the steam-engine, through the intervention of magneto-electric induction, while the old acid batteries of Volta are laid upon the shelf. In this line of research we find especially the names of Ladd, Wilde, and Siemens in England, of Gramme in France, and of Wallace, Brush and Weston in America. Let the question of priority of invention, of superiority in form of construction and of conflicting claims among all these inventors rest for the moment; the grand

and simple fact remains that, given any adequate source of mechanical motion and masses of soft iron properly mounted for revolution and armed with an adequate amount of insulating copper wire, we come from, the simple multiplication on itself of that inconsiderable amount of magnetic force which exists in most soft iron, developed by simple rotation of the bobbins of such an apparatus, to such a volume and intensity of magneto-electricity as is limited only by the power of the mechanical motor at command and by the inductive capacity of the soft iron masses within the environment of the insulated wires of soft copper, *provided* the revolution of the arbor is accompanied with suitable interruptions in the direct flow of the electrical stream. Without the use of technical language, and of good diagrams, which would be of little value without technical description, we can hardly make the subject more easy of comprehension to the average reader. What is the result? Consider the Gramme machine, for example, for we are in Paris and the Gramme machine is unfortunately the only light producing magneto-electric apparatus on exhibition—Weston has his machines here for electroplating doing excellent work, but Wallace is not here, nor Brush, of Cleveland, and so America remains literally in the dark when she should have made a most conspicuous show of electrical illumination—only one more example of our too numerous shortcomings at this Exposition. But to return to the Gramme machine for our illustration. It is simple, powerful, and very compact. It has no delicate parts, liable to derangement; it can be set up anywhere in a few hours without any foundation, and it can be worked for months without delay or interruption. Like any other machine of simple rotation, the wearing surfaces need lubrication. It occupies only a space of about four cubic feet, weighs about four hundred pounds, of which the copper bobbin weighs about seventy pounds, and has a diameter of seven inches, and requires two and a-half horse power to drive it, with 850 turns per minute. Such a machine develops an average illuminating power of about five thousand seven hundred candles. Its intensity depends on various circumstances of position, etc., and may vary between 2,400 candles and 8,400 candles, according to the mode of placing the carbon points with reference to the photometer. This is the type of machine in use for industrial purposes, for practical daily work in illumination of shops, railways and streets. There is in the Exposition a form of the Gramme machine at work which yields, on the authority of M. Fontaine, three times more light for equal quantities of matter in action than any of those which have before been tried in France, England, or elsewhere. This machine weighs 441 pounds, costs £60 ($300), and yields a light equal to 30,000 candles! Notwithstanding its low price and wonderful performance this machine cannot be commended for use, as the elements of durability are wanting in it. But of the form of the Gramme apparatus used in shops it is affirmed that several hundred of these machines have been at work all the past winter, some of them without interruption for underground operation, without costing a farthing for repair or maintenance except for lubrication. In the great foundry of Ducommen and in the shops of Sautter and Lemonnier these machines have been constantly at work for four years without giving the slightest trouble.

I quote from a carefully prepared statement of Messrs. Heilman, Ducommen, and Steinlen the average cost per hour of four Gramme machines which have been run by them in their shops for four years. The charge for interest and depreciation is rated at 15 per cent. on the cost of four Gramme machines and the motor to drive them, viz.:

	Pence Sterling.
Carbon pencils burned....	8·36
Steam consumed.....	3·42
Attendance.....	2·85
Interest and depreciation..	43·45
Total cost per hour.....	63·08

In this case the moving power is only about a twentieth of the total cost, while three-fourths of the total is put to interest and depreciation. The parties whose results we have quoted estimate that the cost of an equal amount of light from gas to that supplied to their establishment by these machines would be double. But the question of relative cost involves many considerations, and must vary with circumstances, and especially with the cost of gas, which in this case is estimated at 7 shillings 6 pence ($1.75) per thousand feet. In Paris the cost of gas is the same to the private consumer, say, 30 centimes per metre cube. The cubic metre is, in round numbers, thirty-five cubic feet; consequently the cost of Paris gas in American currency is $1.75 (say, 8·57 francs) per thousand. But the city pays only half that sum in consideration of the monopoly, and of their having an equal share in the earnings of the company after a certain sum—say, 10 per cent. on the original capital—has been paid to the stockholders.

I am informed, by M. Alphonse Barlet, the engineer in charge of the Belgian railways, that he has installed four electrical lanterns—with the old style of regulator—in the *gare* or station of the Bruxelles Railroad at a total cost of 20,000 francs (say, $4,000) for one Gramme machine, one eight-horse power steam-engine, eight regulators, two to each focus of light (*foyer*) and all the necessary conductors, etc. These four electrical lamps take the place of 120 gas burners (*becs de gaz*) each consuming 150 liters per hour (four and a-half cubic feet). The light now obtained from these four electrical lamps, M. Barlet estimates equal at least to what would be got from 500 such burners as he used before. But for comparison of cost the statement is made, between the 120 burners actually used before and the electrical costs with the general result, that in the long nights when the use of the illumination is for six to eight hours, during about seven months of the year, the electrical light is cheaper than the gas. But in the summer, with only two or three hours' use of the light, the electrical costs more than the gas light. The reason is obvious. The wages of the engineer and the electrician are the same in both cases, and the interest on cost the same for the shorter as for the longer duration of the light. But on the whole the electricity was the cheaper and the light abundantly more than the gas gave. On the other hand, the Northern railway station in Paris, which was illuminated by the electrical lanterns, has returned to the gas. I, however, observed the electrical light in the Western Railway station in Paris. The publications of the Paris Gas Company, which are before me, make it clear that in their judgment electricity cannot compete with gas. I have paid some critical attention to the Paris gas industry, and shall take another occasion to say something in detail upon the works here. It is at present sufficient to say that no more beautiful exhibit exists in the grounds of the present Exposition than that of the *Compagnie Parisienne d'Eclairage et de Chauffage par le Gaz*. And nowhere are the principles of science better combined with the practice of the art than they are in the various works ("usines") of this immense company.

It remains now to say a few words on the regulation of the electrical light—the candle of Jablochkoff, and the new form of the Gramme machine with alternating currents, adapted to the use of the candle of Jablochkoff.

I remember well the excitement occasioned by the first appearance of the electrical light in the well-known sunrise scene of "Le Prophète," at the Grand Opera House at Paris in 1846. The regulator then used was devised by M. Deleuil, a well-known instrument maker of Paris, but his form of the regulator was soon replaced by that of Duboscq, which is an apparatus found to-day in nearly every physical cabinet. In all forms of regulator before the Jablochkoff candle, the unequal march of the two carbons had to be provided for by a mechanism which advanced the positive carbon twice as rapidly as the negative, so that the focus of light remained (or was intended to remain) constant. All forms of the regulator were destined primarily for the voltaic arc, and the difficulty of manipulating two carbon pencils was common to all forms of the apparatus. These difficulties have been in a great degree overcome by the ingenious device of the young Russian officer, M. Jablochkoff, who, by simply placing the two carbon pencils side by side, and insulating them by means of a thin plate of some refractory substance placed between them, has dispensed entirely with all forms of regulating apparatus.

Those who have not seen this very neat little contrivance will understand it if they consider a common lead pencil reversed, *i. e.*, its two wooden halves are the carbons and the central lead is the insulator, only this insulator completely separates the two carbons in all their length. This pencil, or candle, as it is well called, is held in a pince or vise of metal, the two jaws of which represent the two electrodes. At the upper end of the pencil is a narrow bridge of carbon which completes the circuit and like a match is inflamed by the first impulse of the electric current, thus immediately setting up the ignition. After that the arc itself is the conductor, and the light streams out with its well-known brilliancy. Four of these pencils, or candles, are mounted in each of the glass globes and so arranged that they are ignited successively as each one is consumed, the time for each being from one and a half to two hours, according to the thickness of the carbons. The light is not absolutely uniform. There are the well-known variations familiar to all who have experimented with the electrical light, and the violet rays which are so fatiguidg to the eyes are often visible, and, as will be seen by this statement, the duration of the light is limited at present to eight hours. This last limitation can be probably removed by mechanical improvements, which it is needless to dwell on here; and the use of globes in which uranium-oxyd is employed to give its feeble fluorescent tint, will absorb completely the violet rays, without injury to the brilliancy of the illumination. But taken as it is with all its defects, and abating at discretion the too favorable statements of those who are interested parties, we must all agree, who have seen it here in Paris, that it is the wonder of the occasion; and that is saying much, for there are some other wonderful things here of which, perhaps, the great balloon is the freshest novelty. But the use of the Jablochkoff candle involved the necessity of a novel construction in the Gramme machine, and in all other magneto-electric machines of a constant current in one direction. The reason is obvious. The positive carbon is con-

sumed twice as fast as the negative, and this would be fatal to the use of the famous "candle." This difficulty could be met only by producing an alternating current, and this has been successfully accomplished by M. Gramme in his new machine. This has been easily reached by the use of a small magnetic machine, supplemental to the illuminating engine, which acts as a commutator, and which effects, at a velocity of 800 revolutions, a reversal of polarity—alternation of plus and minus—64,000 times in a minute. By this simple device the Jablochkoff candle burns with entire uniformity.

At this moment there are three models of the Gramme machine with alternating currents. The first supports sixteen Jablochkoff candles of "100 becs"—*i. e.*, of an intensity each equal to 100 gas burners—consuming five cubic feet of gas and yielding each 20 candles power. It may be safer to rate these burners at 15 candles, which would be the same as saying each Jablochkoff globe equals the light of 1,500 candles. But this is not what is meant by the statement here. It means that one such electrical lamp extinguishes 100 gas burners; but it is claimed that the actual intensity of light provided is equal to much more than that, as M. Barlet states in his experience in the Bruxelles Railway Station. This first model of the Gramme machine requires an engine of sixteen horse-power to drive it, and costs with its motor 10,000 francs, say $2,000; it welghs 650 kilogrammes, say 1,500 pounds, and makes 600 turns per minute. The whole weight of copper induction wire in action is 103 kilogrammes, about 125 pounds. The second machine is good for six Jablochkoff candles, requires six-horse power to drive it, and costs with its motor 5,000 francs, say, $1,000. It revolves 700 times per minute, and weighs 280 kilogrammes; the weight of copper wire in action is 40 kilogrammes. The third form of apparatus feeds four Jablochkoff candles of 100 becs each, requires four-horse power to drive it, and costs with its motor 3,500 francs, say, $700. It revolves 800 times a minute and weighs 190 kilogrammes, having 28 kilogrammes of copper wire in action. From this statement it appears that one-horse power is estimated for each candle of Jablochkoff, or each 100 gas-burners.

M. Gramme is now occupied on a fourth model which is to feed two electrical lamps, and is much cheaper both in cost and driving power. The Holmes machine and the Gramme machine are alike in the relative position of the bobbins and the electro-magnets, both being alternating currents. By the simple substitution of a plate of plaster of Paris for the kaolin, at first used for the separation of the two carbons, M. Jablochkof has it is claimed, doubled the intensity of the illumination without any increase in the electro-motive force, and the cost of the apparatus has been reduced from 75 centimes to 50 centimes per hour for each electrical candle—100 becs—motive power and depreciation of apparatus not included. I cannot conclude this letter without reverting to the splendor of the electrical illumination of the new Avenue de l'Opera, as seen from the balcony of the Grand Opera. The effect is magnificent, and at this moment there exists nothing in this city of splendid effects to be compared to this magical scene. The surroundings of the Opera itself—the most majestic theatre in the world no doubt—add much to the effect. There are in view about thirty of these electrical lanterns—a part of those near the Opera-House being of the same form (a cone inverted) used by the Paris gas company, the others being the opaline globes, already described. The vista is about two-thirds of a mile, and the effect incomparably finer than any show of artificial illumination ever before seen. It is the light for all public places where a high degree of illumination is desired, as in large shops, cafés, public gardens, theatres, avenues, etc. But it will not displace gas for domestic use, nor for common street lights. Great difficulties in the subdivision of the current are yet to be overcome. For the Avenue de l'Opera I understand there are three steam-engines, and that at present 200 metres is as far as the current is conveyed. But let us not too confidently predict the future of what is possible in this direction. Of one thing we may be certain—the Parisian gas company are wide awake to the public interest in this thing, and will not be slow to add it to their present vast system of works whenever it appears that both their own and the public interest make it desirable they should do so. But in Paris the use of gas in houses is a matter of much less moment than in America, for the old prejudice excludes gas both in London and in Paris to a great extent from domestic use; candles, and carcel lamps burning colza oil, still shine in all the *salons* in Paris. When, then, we learn that the share of profits paid over to the city from their one-half interest in the earnings above 10 per cent. first paid to the Shareholders' Association last year, amounted to the round sum of 8,000,000 francs, we can readily understand that the city will act with the company in aggregating any valuable improvement in public illumination to their existing franchises, and that they can well afford to do so even at a pretty round price. The present capital of the gas company is, in shares, 84,000,000 francs, and in debentures 111,745,000 francs, or in the total nearly 200,000,000 francs, or $40,000,000. The modest little capital of 7,500,000 francs which the electrical company represents would be only as dust in the balance to such a huge monopoly. It is interesting to note that the amount paid last year by the city of Paris for gas was 7,827,205 francs—a little less than the dividends received from the company. But it must be remembered that the tax paid into the city treasury by the gas company last year was 8,500,000 francs, and that the several water companies paid a little more than that—viz., 8,924,577 francs. By this shrewd arrangement the city of Paris annually gains net over all costs for gas more than 8,500,000 francs. When will the several gas companies in New York combine to pay the city as much for their monopoly? Probably not in the fragment remaining of this century.

[From Correspondence of the London *Journal of Gas-Lighting.*]

Testings for Illuminating Power and Their Difficulties.

Sir—The North British Association of Gas Managers, in their circular of the 20th inst., invite members to contribute papers for the meeting in July next, at St. Andrews, and suggest a variety of subjects for such papers. One is "On the Relationship between the Various Tests of the Illuminating Power of Gas." Taking the test by the photometer as the ultimate determination of illuminating power, every gas manager who habitually employs subsidiary or inferential tests must have found frequent discrepancies between the reality and the inferences so deduced; and, perhaps, there is no matter connected with gas manufacture that stands so much in need of careful investigation, in order to the establishment of more exactitude in their relations, and the explanation of the causes of discrepancy, and how such can be avoided or corrected.

While generally it is true that an increase in candle power gives a nearly corresponding increase in the durability of a cubic foot of gas in sustaining a fixed length of flame, and an increased per centage in the volume condensed by bromine, and *vice versa*, it is found that these proportional relations become perplexingly disturbed from other causes, and, notably, from fluctuations in the temperature of the retort within which carbonization is effected. It has often occurred in my experience that in repeating a test of coal already tried, and immediately after, if the heat should have varied from "dull red" to "moderate," or from that to "sharp," the comparative results are so divergent that it is difficult to identify them with the same mineral; thus pointing to the felt want of some efficient methods whereby temperature, and period of exposure to carbonization in the retort, could be regulated to bring out the best results from any given quality of gas coal.

I may venture to suggest that this subject is well deserving the attention of our younger and advancing gas engineers, and any practical solution of the question, arrived at through careful investigation, would be sure to meet with a hearty welcome at the next annual meeting.

In the course of a rather lengthened experience, I have tested all the best known varieties of Scotch cannel coals, and preserved the records thereof; and there is nothing so perplexing as to find such varying results in different trials of the same coal, especially in respect of the bromine and durability tests, when compared with the candle power by the photometer. I annex a few examples of these tests taken within the last few weeks, some of which in the repetitions exhibit such discrepancies. I may venture to say that the trials were all made with the greatest personal care, and that the manufacturing and testing apparatus are of the best kinds.

The retort is of cast iron, 7 feet long by twelve inches in diameter, and is associated with complete condensers, purifiers, station-meter, and everything to match. The temperature of the retort, judged by the eye, was variously noted, as in the annexed table (see next page), and, as compared with fire-clay retorts, I find the action of the iron retort at *fair heat* has an energy equal to a clay retort at *bright sharp*.

Perhaps the suggestion of this topic of inquiry may result in something worth the trouble, if you see fit to give it a place in the *Journal*, and the figures in the table may afford some examples requiring solution.

The particular coals tested are well-known Scottish cannels, which, for obvious reasons, it is expedient should only be distinguished by letters of the alphabet. JOHN REID.

Edinburgh, March 30, 1878.

Sir—It afforded me much pleasure to find, in your last issue, my esteemed friend, if he will allow me to call him so, Mr. John Reid, again coming forward with suggestions and matter for the exercise of thought, not only on the part of the younger members of our profession, but also on the part of those who, like himself, have had years of practical experience.

The problem which Mr. Reid desires to be solved is a very difficult one, because all the factors which go to make up the equation are not, as I conceive, really known, and he will, I am sure, pardon me for saying that the statements which he puts forward require to be supplemented by

Name of Cannel.	Heat of Retort.	Produce of gas per Ton of coal. Feet.	Per Centage condensation by Bromine.	Duration of one cu. ft. Single-hole Jet, four Inches long. Min.	Sec.	Candle power by Photometer.	Remarks.
A	Fair Heat.	12186	14.00	80	00	31.61	These not cons'c'tv, but same coal; 4 yrs interval
"	Sharp.	14453	11.00	76	50	33.20	
B	Fair Heat.	11040	12.00	75	40	36.30	Consecutive.
"	Sharp.	11760	12.50	80	00	34.90	
C	Fair.	10133	8.50	65	00	20.66	Consecutive.
"	Low.	9933	7.25	62	30	22.90	
"	Sharp.	10880	6.25	57	30	18.50	
D	Fair.	12085	8.40	69	00	27.54	At 3 weeks interval.
"	Sharp.	12373	9.25	66	40	22.50	
E	Fair.	10560	10.50	75	00	32.20	Consecutive in 1873.
"	Sharp.	10906	11.25	72	00	31.08	
E*a*	Sharp.	11696	9.00	64	00	24.00	Same as last coal, tested c'secutively Mar. 1878.
"	Fair.	10288	11.25	71	30	28.60	
F	Sharp.	10533	9.50	65	00	23.19	Consecutive.
"	Fair.	10000	9.00	67	00	25.42	
G	Sharp.	11200	4.00	50	00	11.93	Consecutive, 1878.
"	Fair.	10200	4.75	55	00	13.77	
H	Fair.	10923	10.00	68	20	31.14	Consecutive, 1878.
"	Sharp.	12016	9.50	66	40	31.42	
K	Fair.	13597	11.25	71	20	31.61	Consecutive, 1873.
"	Fair.	13619	12.20	75	30	32.24	
L	Sharp.	12192	8.00	63	20	23.03	Consecutive, 1878.
"	Moderate.	11200	11.10	73	30	28.63	
M	Sharp.	10080	3.25	50	00	10.20	Poor Splint coal.
"	Fair.	8413	3.50	50	00	9.20	
N	Fair.	9866	9.75	72	30	28.76	Consecutive.
"	Sharp.	10066	9.00	68	20	27.56	

others before any proper conclusion can be deduced.

In the "Remarks on Photometry," which I had the honor of reading before the British Association of Gas Managers, in the year 1870, I drew specific attention to the possible errors which might occur in the indications of the jet photometer, as used by the late Mr. Geo. Lowe, and of the durability test, as employed by the late Dr. Fyfe, and after some reasoning on the subject, said, in respect to the latter test:

"The durability test, pure and simple, may not be entirely free from possibility of error, for although the determination of value is dependent on time and volume, or, what is the same thing, on the rate of consumption, yet if flames produced by consumptions of equal *weights* of a combustible becomes enlarged or reduced as the atmospheric density diminishes or increases, it may be that equal *volumes* of gas will at different atmospheric densities produce flames of equal length, and thus lead at times to the under or over estimation of the illuminating power of the gas."

If my reasoning be correct, it follows that every determination of the value of a gas by the jet photometer of Mr. Lowe, or by the jet as used by Dr. Fyfe and his successors, should be accompanied by corrections for barometric pressure, and for temperature, just in the same way as is done now in London, under the Referees instructions, in the estimation of the illuminating power of gas with the Bunsen photometer.

The information required to supplement the particulars which Mr. Reid has given are, as far I can see at the moment, to be found in answers to the following questions:

1. Was the volume of gas produced per ton of coal or of cannel, in every case reduced by calculation to standard volume at 60° Fahr. and 30 inches barometer?
2. Was the volume operated upon with bromine also so reduced?
3. Were the volumes used with the durability test and with the Bunsen photometer also so reduced?
4. What were the specific gravities of the several samples of the gas?

In respect to the first question, I assume, as a matter of course, that the needful corrections were made, because a gentlemen of Mr. Reid's experience and capacity is not likely to neglect so important a matter, but in respect to the second and third questions, I feel by no means certain, for as regards the bromine test and durability test, at all events, it has not been customary, as far as my experience in the South goes, to correct for atmospheric conditions. The fourth question may be of little import; but I put it because I am by no means sure that specific gravity may not be an important factor when taken in connection with the condensation and durability tests.

It has, I think, been pretty well established that the photometric value of gas is not so much dependent upon the percentage volume present of hydrocarbons condensable by bromine as upon the character or composition of those hydrocarbons. Hence we may naturally expect to find great apparent discrepancies between the indications afforded by the bromine test and those afforded by the Bunsen photometer. Such discrepancies belong to experiences of a good many years gone by, when Mr. F. J. Evans, in the tables he published, showed that there was but little value to be attached generally to the indications of the bromine test, unless the *density*, as well as the *per centage volume*, of the condensable hydrocarbons were ascertained.

I abstain from any attempt to analyze the results given by Mr. Reid, first, because I have not time just now to spare; and, secondly, and more importantly, I have no desire to anticipate the production of a good paper by some one else on the important subject in question. I cannot, however, help saying that I am gratified to find that the results obtained with the Bunsen photometer are, to say the least, fairly consistent among themselves. This seems to indicate that our old servant, the sperm candle, is not such a bad fellow after all, if properly treated. He may not be very scientific, but, anyhow, he is useful.

F. W. Hartley

55, *Milbank Street, London, S. W.*,
April 12, 1878.

Sir—The subject of Mr. Reid's letter, published in your last issue, is one of considerable interest to all gas manufacturers, and it is to be hoped may be thoroughly investigated by the members of the North British Association of Gas Managers.

I have myself given the matter some little attention, in the expectation of being able at no distant date, to make known the results of my experiments; but failing just now the requisite leisure for them, I may just suggest to Mr. Reid, and to others who may be interested in the inquiry, that one of the conditions essential for the obtaining of uniform and comparable results, is equality of temperature of condensation.

Charles Hunt.

Birmingham, April 12, 1878.

Sir—The table given by Mr. John Reid, in his letter in your *Journal* of the 9th inst., is simple and honest, but it appears to me to indicate a defective course of analysis. I am sorry your correspondent has not given the weight of each sample per cubic foot, that being the first step which often inspires confidence, when the bromine and duration tests gave conflicting results against the photometer.

I am not astonished at the gas engineers in Scotland looking out for something better than bromine and height-of-flame as definite tests; I hope, when they have decided on something better, it will not be a looking-at test. They may obtain results by weight, which will prove how useless these tests are, and prompt them to abandon the enormous waste of unfixed hydrocarbons caused by the use of gas from cannel only. Every practical experimenter must admit that the small volume of gas collected over water in the Cooper's tube, acted upon by bromine, absorbed by potassic hydrate, collected and estimated at the same temperature, is a very doubtful experiment, because the volume in the tube under atmospheric changes alters in composition from equal distillates of coal.

The same applies to the height-of-flame test, and if Mr. John Reid will try the following experiment, it will satisfy him of the uncertain results. Suppose, with the barometer at 30°, and the thermometer at 60°, two U-tubes, 6 inches long, half-inch bore, and fitted with perforated rubber corks, with one-eighth inch glass tubes bent at right angles, fixed tight in each arm, and each weighed filled, the first with granulated calcic chloride, and the second with granulated potassic hydrate. Connect them together in the order mentioned, and measure per meter through them a cubic foot of the gas. Reweigh each tube, and note the *plus* weight. Repeat the experiment when the barometer is at 29°, and thermometer at 70°, also note the weight. Then ask yourself what effect has the water in the gas and in the atmosphere upon the volume of the gas in the Cooper's tube, and upon the volume of gas required to give the height of flame, and how such an atmosphere acts upon it. If Mr. Reid will then weigh the other three U-tubes together, three and four with washed dried coke, saturated with standard Nordhausen sulphuric acid, and the fifth tube with granulated potassic hydrate, and pass half a cubic foot through the five U-tubes during three-qnarters of an hour, he will then have the exact weight of one cubic foot of water vapor, carbonic acid, and unfixed hydrocarbons, in grains per cubic foot.

There is not a more useful instrument in the experiment-room than Schilling's specific test for estimating the exact weight of one cubic foot of gas from any sample of coal distilled. This knowledge, acquired as a first step, will inspire confidence in the practical course which I have described.

I can obtain the true value of coal and gas by the volume, and the weight of unfixed hydrocarbons in that volume, at a given temperature, without the aid of the bromine or duration tests. The photometer is the standard; but your readers would be rather amused at the Referees with

(*Continued on 2d column, page* 103.)

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MONDAY, SEPTEMBER 2, 1878.

Official Report of Examinations of Gas for two Weeks ending Aug. 24, 1878, made at the Photometrical Room of the Department of Public Works.

Corrected Illuminating Power.

Aug. 1788.	Time of Day at which Test were made.	New York Gas Light Co.	Manhattan Gas-Light Co.	Mutual Gas-Light Co.	Metropolitan Gas-Light Co.	Harlem Gas-Light Co.	Municipal Gas-Light Co.
12	Between 6 A. M. and 9.30 A.M.	16.00	16.58	20.40	16.66	16.27	
13		16.19	16.20	19.94			
14		15.52	16.42	18.43	16.03	16.17	
15		16.06	16.75	18.44	17.41	16.36	
16		16.16	17.56	20.39	16.92	16.16	
17		17.49	17.58	22.33	17.86	16.75	
	Average	16.24	16.85	19.99	16.98	16.34	
19		15.69	17.37	18.92	17.43	16.45	
20		16.61	16.94	19.19	16.90	16.93	
21		16.43	16.34	19.08	16.82	16.12	
22		16.21	16.20	19.24	17.42	18.34	
23		16.52	15.42	17.95	16.61	17.12	
24		16.08	16.42	19.18	17.39	16.93	
	Average	16.26	16.45	18.93	17.09	16.98	

Sugg-Letheby burner.
E. G. LOVE, Gas Examiner.

PRICE OF GAS IN MILWAUKEE.—In our last issue we stated that the Milwaukee Gas-Light Company had reduced the price of gas from $3 to $2.50 per 1,000 feet. It should read that the price of gas had been reduced from $3 to $2.25 per thousand.

(*Continued from page* 102.)

the weight of hydrocarbons required to give 16 candles, estimated by their newest standard burner, and the weight required to give 16 candles estimated by the old standard. The difference will prove the necessity of the volume and weight test described above.

W. L., P. B.

April 13, 1878.

Sir—A proper reading of my letter, in the *Journal* of the 9th inst., might have saved my friend Mr. Hartley, and your anonymous correspondent, W. L., P. B., their trouble in describing the correct methods whereby other important analytical processes in relation to coal gas should be conducted. But one moment's reflection will show that they do not touch the simple question I suggested for solution by a practical gas manager, and which bears closely on a subject of every-day use by him, but may be stated in simpler terms, thus:

Given—A particular specimen of well-purified coal-gas, showing by a good photometer an illuminating power of (say) 30 candles. Required—A correct formula to determine, from the ascertained candle power, the corresponding condensation by bromine, and the minutes duration of a cubic foot, under the durability test, due to such candle power, and *vice versa*.

Both of these inferential tests are much in use by gas managers. And the greatest number of printed analysis of Scotch cannel coals give prominence to the bromine and durability tests as having a *qualitative* relation to the illuminating power, but which puzzles as much as it enlightens. I give an example from three such reports on as many specimens of first-class Scottish cannels. Each of the three reporters (carefully reducing all to the atmospheric standards of 30 inches and 60°) is a man of acknowledged ability and excellent judgment in determining the true value to the gas manufacturer of the minerals reported on. The only anomaly being the confusion which arises in any attempt to reconcile these two inferential tests with the actual candle power determined by the photometer. The figures below will speak for themselves :—

Analyst.	Name of Coal.	Condensation by bromine.	Durability of 5-inch Single hole Jet.		Illuminating Power by Photometer.
		Per cent	Min.	Sec.	Candles.
No. 1.	A	16.00	70	00	38.00
No. 2.	B	22.00	68	38	39.11
No. 3.	C	19.00	65	00	36.01

JOHN REID.

Edinburgh, April 20, 1878.

The White Incrustation on Bricks.—At a meeting of the Philadelphia County Medical Society, held December 26, this subject was reported upon by the Committee on Microscopy, Dr. Joseph G. Richardson, chairman. The committee decided the white deposit to be sulphate of magnesia, better known as epsom salts. In the deposit, the microscope revealed the presence of epithelial scales from the human skin, and the *debris* of many plants. The sulphuric acid comes from the coal gas and the coal burned in the city; the base, or magnesia, is from the bricks themselves, a large quantity being found in the clay of which they are made. It is not regarded as in any way injurious, though quite unsightly and destructive to the walls. This coating may be prevented by a thick coat of paint on the wall, or the immersion of the bricks before use in a bath of sulphuric acid, and subsequently to the action of running water.—*Scientific American.*

[From "Journal of Gas Lighting."]

British Association of Gas Managers.

Mr. G. ANDERSON said he would describe a work in which he had been engaged, as bearing upon the question dealt with in the paper just read. He had had a tank to build for gas-works, where the bottom of the ground was a peat bog, the peat lying at an angle of about 30° to the surface of the ground. He could not go down to the level of the peat, and therefore decided to float the tank on the bog, and to build it of concrete in the manner Mr. Livesey had recommended, without a single brick or any masonry. He first dug a vertical channel 9 feet wide all around on the site of the tank, into which he put a bed of concrete, 3 feet thick and 9 feet wide, with a skew back to the face of it. He then put his walls on the back of the concrete. He commenced by putting a layer of timber under the concrete, and began at the side where the turf was deepest, and there made the wall 6 feet higher than at the other side, expecting that it would sink more. After having finished the walls, his next object was to take out the interior, and he intended to form a bottom in the shape of a frustum of a sphere, so that it should be able to support the internal pressure. He feared, however, that the great thrust of this on the walls might split them, and therefore put into the concrete three strong iron hoops, about 5 inches broad by 5-8ths of an inch thick. The first year he only built the walls, and did not form the bottom, but put the materials of which it was to be constructed on the top of the walls, so as to load them, and cause them to sink as much as possible. During that winter they sunk 6 inches lower on one side than the other, and he had to restore the level by putting in more concrete. In doing so, he made the lower side 2 inches higher, expecting that it would still go down again. It not only did that, but sank 2 inches more; in fact, it sank about 15 inches on one side and 10 inches on the other during the course of the year in which it was erected. During the whole of that time. however, it never cracked, and it was now as tight as any tank he ever saw; so much so, indeed, that it overflowed with every shower of rain. The whole of the tank was rendered with cement.

Mr. SMITH (Darlington) asked Mr. Anderson whether the wall kept plumb when it sank 15 inches on one side and 10 inches on the other, and, if so, how it was there was no crack.

Mr. ANDERSON said it did not keep plumb, the whole thing went over slightly as a solid mass. It necessarily went out of plumb, in sinking, perhaps one-half or three-quarters of an inch, and the guide bars were set accordingly.

Mr. GEORGE LIVESEY (London) said he had listened with great interest to the paper just read, but there were one or two points in which he thought it would be advisable to be somewhat careful. For instance, with regard to the tenacity of cement. According to his experience, it would not do to rely on that to prevent a tank cracking. His tank, to which reference had been made, was 45 feet deep and 184 feet in diameter. When filled with water to about 30 feet of the top, it remained sound for some months, while the gasholder was being put in; but when it was entirely filled, five or six small cracks took place. Now, if the concrete was possessed of such enormous tenacity as was represented, it was rather astonishing that a thick wall should crack from the top to the bottom with no apparent force to produce such an effect. One would think that it would go off like the report of a gun; but, on the contrary, it seemed as if it parted with perfect ease, and as if there was no tenacity whatever it it. The cracks opened to the extent of about 1-16th of an inch, running from the top nearly to the bottom, and almost vertically right through the concrete, causing a slight leakage. He had, therefore, come to the conclusion that it was necessary to take extraordinary precautions to back up or support the concrete where puddle was not used. Where puddle was used, the concrete or brickwork was in perfect equilibrium, the puddle being the thing which held the

water, whilst the concrete or brickwork held the puddle in its place. Where, however, concrete was employed, and rendered with cement, it was important that it should be thoroughly supported to resist the pressure, the whole of which was exerted on the thin skin of rendering. Unfortunately, the pressure came at a time when the tank was least able to stand it—just after the tank had been constructed, within six or nine months, when the concrete had not had time to harden and develop its full tenacity. The same difficulty had been experienced in France. He had seen a report in the *Journal of Gas-Lighting*, some time back, of a French tank built of concrete, which had cracked in the same way. That tank was backed up with sand, solidly, as they thought, but still not with sufficient solidity to prevent all expansion of the concrete, and the result was that it cracked or opened. Water was allowed to pass behind it, and thus its equilibrium was restored. He should be inclined, although he objected to it some time ago, to put iron bands into the concrete, especially in the upper part, where the wall was thinner and the backing was not so solid, to resist any strain which might be put upon it when first built. He had certainly not lost his faith in concrete, but he did not say it was to be used everywhere. If he had no gravel at hand, and bricks were cheap, he shonld use them, and in like manner he should not dispense with puddle if he were constructing a tank in clay. Where there was no clay, where bricks were dear, and materials for concrete were cheap, there was no question which was the right course to pursue He did not like puddle at all, and, wherever it was possible, should avoid using it, for he had had a great deal more trouble with puddled tanks than with concrete ones. There was one error in the paper just read which he ought to correct—namely, where it was stated that Mr. Wyatt was the first to construct composite tanks. That was not so; the composite tanks for the Chartered Company were not decided upon until Mr. Docwra showed Mr. Evans the plans of one to be constructed at the South Metropolitan Works on the composite plan. The Chartered Company then decided upon it, though they were thinking of it before. With regard to concrete, any material almost might be used, provided it was clean and free from loam. One of the best things to mix was the useless clinkers from the furnaces. They mixed well with concrete, and all descriptions of cement had a hold on them which they hardly had on any other materials. These clinkers, therefore, in stead of being a drug, might become of great use where building operations were going on.

Mr. Paterson (Cheltenham) said he understood from the paper that the writer did not approve of the ordinary method of mixing concrete in the dry form, but advised that the cement should be mixed with water, and poured over the ballast. That was rather important; but he should never think of doing it in that way.

Mr. Hartley said that was only with reference to certain tanks made abroad for wine.

Mr. Livesey said he was not so much interested in wine tanks as in those of a different description. He understood that Mr. Richards recommended that the ballast should be wetted, and then the cement applied, but not in a liquid state. That was certainly contrary to all his experience in the matter. The rule was to turn over the materials twice by hand, dry, then to mix the water, and turn over again twice. They also had a further mixing from being put into the barrows and deposited in position. Cement certainly could not be properly mixed with ballast if it were wetted in the first instance.

Mr. Hartley said what Mr. Richards laid more stress on was the wetting of bricks or stone—bricks especially.

Mr. H. Gore (London) said that, having had some experience in the use of concrete, there was one matter which appeared to him to deserve some notice He understood the writer of the paper to recommend mixing Puzzolana with lime; but he (Mr. Gore) found it was dangerous to use it, especially for a water-retaining tank when in contact with lime. It was to all intents and purposes a volcanic cement, due to the decomposition of certain matter, and when it was used with lime, and exposed to the action of water, after a time it underwent fresh decomposition; the lime apparently extracted the cementing material, and the tank constructed with the composition became, to a certain extent, a colander. He might say that time was one of the most important elements in judging of the practicability of using concrete. His own experience had been that concrete which required the greatest time to become perfectly solid was that on which the greatest reliance could be placed as to the ultimate result, and this was only a natural consequence, bearing in mind what took place. In the mixing of concrete, certain materials were taken and surrounded with a substance which underwent some chemical change; in this process the water took a new form, entered into combination with these materials, and in proportion as that recrystallization took place, so would perfect cementation result. Therefore the longer time that could be allowed for the process, the more perfect would be the result. The experiments referred to entirely bore out that view. It was shown that if a number of dry bricks were put together with cement, crystalline action did not go on, simply because there was no permeation of the water of crystallization with the minute particles of cementing material; but if the brick was immersed in water, all its pores were in a condition to absorb the cement, and thus the effect was produced which was so essential for a permanent solid tank.

Mr. H. P. Stephenson (London) remarked that his experience in the use of Puzzolana differed entirely from that mentioned by Mr. Gore. When engaged, many years ago, on the Sunderland Dock, he used it very largely indeed, and found that it became as hard as a stone. It was used in connection with blue lias lime and sand, and the mortar to the present day stood as well as the day after it was set. On the general question, he thought Mr. Livesey had summed up the matter very carefully, with one omission—namely, that concrete tanks ought to be carried out by very careful workmen, and under a very careful engineer. If these points were attended to, they might be safely adopted.

Mr. Hunter (Salford) wished to say one word to justify a work in which he was himself engaged. He understood the writer of the paper to regret that engineers of the present day were still following the lines of 50 years ago in the mode of constructing tanks, and to express an opinion that the antiquated method of building them with bricks and puddle ought no longer to be continued. He (Mr. Hunter) was at present constructing a very large tank on that old-fashioned plan, simply because, while he altogether agreed with what had been said about concrete, he could, under the circumstances in which he was placed, build a brick and puddled tank much cheaper than if he used concrete, because he was building upon a bed of clay.

Mr. Warner (South Shields) said that at the mouth of the Tyne immense quantities of concrete blocks were manufactured, generally measuring about 10 by 6 by 4 feet. The arrangement in use there was to employ, in the construction of these blocks, a cylinder with two sides cut off, which cylinder was hung by a travelling crane above the moulds, into which the concrete was allowed to fall. The materials were placed in the cylinder, and four men, by means of a winch handle, turned it round so many times, and then opened a door, through which it fell into the mould. He had used a similar arrangement for some time; but, instead of a winch-handle, he placed a drum on the cylinder, round which a rope was wound, and a horse attached to it, so that the motion of the horse rotated the cylinder.

Mr. Mead (Sutton) said that when Mr. G. Livesey read his paper some time ago on concrete tanks, he stated, in answer to the writer, that he preferred the old-fashioned practice of puddling. Since then he had had some experience with a concrete tank, 102 feet in diameter, built something on the same kind of site as that described by Mr. Anderson, being on the side of a hill, and on very bad boggy ground. The engineer who designed it, endeavored to support it by building some strong piers against the weak side of the tank, but soon after it was built the water managed to get underneath, and came through at the rate of three feet in 24 hours. That mischief was remedied, and the tank filled again, but the next thing that happened was that it cracked close by the side of the pier, the crack descending to five feet from the bottom, which allowed the water gradually to run away to that level. On a former occasion he had stated his objections to building iron hoops into concrete, because he thought they would expand and crack the concrete, and he then suggested that a hoop round the outside would be the better plan. He was now going to try that, and, if successful, he would state the result at the next meeting. He believed that if the tank referred to had been built on the old-fashioned plan, it would be sound now.

Mr. Hunt (Birmingham) said he gathered that Mr. Livesey attributed the cracks in his concrete tank to the water on the inside. He should like to ask him what depth below the coping the cracks occurred, and whether he estimated the pressure caused by the water inside as against the pressure on the outside of the wall. It was important to ascertain whether it was really the pressure which caused these cracks, or the shrinking of the concrete from imperfect mixture.

Mr. Livesey said he felt no doubt it was the pressure of the water. He calculated it, and found that, unless the backing was very solid indeed, cracks might be expected to take place. The backing was formed of solid sand, well rammed, but, solid as it was, there was just sufficient elasticity to allow the tank to give a little, which resulted in the cracks. They were very slight, and no inconveniences arose, but still there they were, running from top to bottom.

Mr. H. Veevers (Bolton) said he had constructed a large tank 142 feet in diameter and 32 feet deep, without puddle, without cement, and without sand. He did not use cement because he preferred hydraulic lime ground with clinkers from the furnaces. It seemed to be the fact that hydraulic lime got stronger the longer it was left, whereas cement stopped at a certain point, when it took the formation of stone, and if it cracked, it would crack like stone. To avoid the walls cracking, he was careful to back up the brickwork with gravel thoroughly soaked with water. He was much struck with the remark of Mr. Stephenson that a concrete tank required very great care, because he did not think it required any more care than a puddled tank. If a puddled tank leaked in the slightest degree, there was a tendency for the puddle to get washed away, and the hole to get larger; but in the case of a cement or hydraulic lime tank, the fissure would get blocked up, and would not be aggravated by constant washing away.

Mr. Hartley, in reply to previous speakers, said he was sure Mr. Richards would be pleased to find what an interesting discussion his paper had given rise to. The substance of the paper was that, in making concrete tanks, great care should be exercised in the mixing of the materials and in the construction. He thought Mr. Hunter was under some apprehension as to the signification of the expression used, and that the writer did not intend any reflection on engineers who used puddle, but rather suggested that, in many cases, Portland cement might be used with advantage, and puddle dispensed with.

The President said he had been sometimes struck with the fact that year by year the same matters were brought up for discussion at the meetings of the Association, and did not seem to be definitely settled. This appeared to be the case this year, inasmuch as the remarks made by Mr. Livesey pointed clearly to the fact that in some situations one system might be the very best possible, whilst it would be utterly inapplicable in another. As to constructing a tank without puddle, he should like to repeat the opinion he

had already expressed more than once, that where puddle was to be had at all it was very undesirable to omit it. In the case of the cracks referred to, as appearing in concrete, he thought they were more likely to be due to a slight contraction which took place in the drying, than to the pressure exerted by the water. He said this with great deference, but he founded it on this fact, that observing the walls of the Victoria Docks extension recently, he found that although they were of great thickness—22 feet or 23 feet—yet at about every 100 yards there regularly occurred a crack from the front to the back throughout the mass, although there was no pressure upon them whatever. This must clearly have been due to some slight contraction in the body of the concrete, and for this reason he thought that, in the construction of tanks, where puddle was to be obtained, it was desirable to use it. The things to be opposed to each other were brick and concrete, or puddle and rendering, and he perfectly agreed with Mr. Stephenson that it was necessary, where concrete was used—especially where layer came on layer—to exercise the most minute and careful attention to the work in its progress. There was one point mentioned in the paper which was well worth the time devoted to it—namely, the necessity for saturating the materials with which the work was done, whether bricks or ballast, for making concrete thoroughly with water before they were encorported together.

Mr. Alfred Penny (London) read a paper on

TRANSFER OF GAS-WORKS.

It may possibly be considered that the subject of the paper now about to be read is somewhat foreign to the main objects of this Society, but the matter has of late assumed such large proportions, and the transfer of gas undertakings to local authorities has been of such frequent occurrence, that it has been considered by the council to be a fit subject for discussion by the members of this Association.

It may fairly be asked, why should an industrial undertaking, such as the manufacture and sale of gas, which has been established by private individuals, for the supply of a public want, at their own cost and risk, be subject to interruption and control by public authori ies of any kind? The answer is that the distribution of gas involves an interferance with the Queen's highway, and a breaking up of streets and pavements, which cannot be done legally without the authority of Parliament; and, although many small companies carry on their operations without statutory powers, it is well understood that this is done at considerable risk and disadvantage to the gas company, if, as frequently happens, any differences should arise between them and the local authority of the district.

It is worthy of remark that there are but few instances of a public authority having established gas-works for themselves, Manchester being one of the few towns that have done so.

As a matter of history, it is well known that when gas lighting was first introduced into England, the profits upon the capital invested were generally very small, and sometimes absolutely *nil*.

At that time, therefore, no disposition was felt by the local authorities to acquire the g s undertakings supplying their districts, and it was only when these undertakings began to be profitable that the possession of them was coveted by the public bodies, who had, as a rule, done nothing to aid or assist them in their early struggles.

As the value of gas as an artificial light became more fully appreciated, and its use extended, the returns upon the capital invested increased in a like ratio, and gas undertakings began to take rank as a solid and permanent investment for capital.

Then commenced the attacks upon gas companies whose operations had become sufficiently prosperous to tempt the cupidity of local authorities.

These attacks took various forms; sometimes it was a clamor about price, sometimes about quality, and an alleged insufficient supply; but it invariably led up to the real object, which was a desire to become the owners of a profitable undertaking.

Fortunately, this object could not be attained without the assistance and consent of Parliament, who very early made it understood that they would lend no countenance to schemes which involved something like a confiscation of vested rights.

Many attempts were made to acquire gas undertakings compulsorily, but all ended in failure; and whenever Parliament were asked to confer upon local authorities statutory powers to acquire and hold a gas undertaking, or to erect works in competition, these powers were never granted until after they had agreed to purchase, at its commercial value, the undertaking of the gas company whose district they desired to supply.

The plea put forward in justification of these attempts was the public good, it being contended that the supply of gas ought to be in the hands of public authorities, because its distribution involved interferences with the roads and streets, which were under the control of the said authorities; and that the profit made by the gas companies, and divided among their shareholders, ought to be made available to pay for public improvements, or to diminish rates.

It was also contended that after a company had succeeded in making a profit sufficient to pay their maximum dividends, that they had no longer any motive for economical working, and that to avoid reducing the price of gas, and for the purpose of employing capital, they would make unprofitable extensions, and also pay large salaries to their managers and *employees*.

This is a small sample of the allegations made against gas companies by local authorities when attempting to get possession of their undertaking.

It will be, I think, quite unnecessary for me to deal with these statements at any length; but having had a tolerably large experience in the examination and dissection of gas companies accounts—somethimes in rating cases, sometimes in connection with applications to Parliament for statutory powers, and also as the professional adviser of many gas companies—I am enabled to say that these statement are, as a rule, incorrect, and not capable of proof.

My own experience is that, however prosperous a company may be, the directors invariably use their best exertions to buy everything required for the purpose of the company at the lowest possible rate, and certainly, as a body, they have not exposed themselves to the charge of paying their officers too liberally; on the cantrary, it is my deliberate opinion that they too often err in the opposite direction, and, having regard to the positions of trust and responsibility held by the managers of gas works, they are, as a rule, insufficiently renumerated for the valuable services they render, and there is, consequently, no saving that can be made by public bodies in either of the above cases.

The one solitary advantage a public body would have over a company would be in the lower rate at which they would raise money for the extension of the undertaking, as compared with the authorized dividends of the company upon their share capital; but, as I shall presently show, even this has ceased to exist.

It is, perhaps, fair to state that the transfer of gas-works in some large towns has been precipitated, if not actually brought about, by the dissensions of rival companies, and the disregard of true economical principles exhibited by them in the conduct of their undertakings; and, notwithstanding the *ad captandum* argument that competition *must* be of advantage to the consumers of gas, the public were not slow to perceive that a duplication of main pipes through every street, with the attendant annoyance and cost caused by breaking up the roads, besides the expense of a double staff, with rival boards of directors, &c., could not, in the long run, be to their advantage.

In some of these cases the companies concerned were wise enough to amalgamate: but in others, where party feeling was too strong, legislative pressure was brought to bear upon them, and the undertakings passed into the hands of the local authorities.

This state of things has, however, long ceased to exist, as Parliament have permanently recognized the fact, that it is for the true interests of the public that gas companies should *not* be allowed to compete with each other: but should, in the interests of the public, be placed under proper legislative restrictions, and become, in fact, regulated monopolies.

By the recognition of these principles, and by agreeing to abandon competition, and by districting their respective undertakings in 1860, the great London companies have been enabled to hold their own, and to bid defiance to all attempts of the public authorities of the Metropolis to take from them the conduct of their various undertakings.

I will now speak of the effects of modern legislation upon the interests of gas companies, as bearing upon the question of the transfer of gas undertakings to local authorities.

By section 56 of the companies clauses Consolidation Act, 1845, a gas company having, under the powers of a special act, raising capital partly by shares and partly by loans, were entitled, with the consent of the shareholders, to create additional shares at par, and to pay off the loans—to turn their borrowed money into share capital.

This valuable privilege has now been withdrawn from gas companies, as Lord Redesdale insists upon a special clause being inserted in every gas bill, which prohibits any such dealing with that portion of the capital authorized to be raised by loans, except on the condition that shares so created should bear a dividend of not more than 5 per cent.

And by clause 58 of the same act, any new shares created under the powers of the special act of the company were "to be apportioned amongst the then shareholders in proportion to the existing shares held by them respectively.'

I need hardly state that this is now a thing of the past. The standing orders of last session, which made it compulsory upon all gas companies applying to Parliament, either for a new special Act of Incorporation, or for additional powers, to insert what are known as the "auction clauses" in their bills, have withdrawn from statutory companies one of their most valuable rights.

The concurrent introduction of a standard price and a sliding scale is doubtless some alleviation; but, in practice, I think it will be found that but few companies will be in a position to avail themselves of its advantages.

The effect of all this is, in my judgment, to take from the shareholders of gas companies all pecuniary interest in the future extension of their operations.

We will now turn to the Gas Works Clauses Act, 1847.

By section 30 a limitation of 10 per cent. per annum is placed upon the profit allowed to be divided by the company upon their original paid-up share capital.

Section 31 is of so much importance for my argument, that I make no apology for transcribing it entire—

"If the clear profits of an undertaking in any year amount to a larger sum than is sufficient, after making up the deficiency in the dividends of any previous year as aforesaid, to make a dividend at the prescribed rate, the excess beyond the sum necessary for such purpose shall from time to time be invested in government or other securities; and the dividends and interest arising from such securities shall also be invested in the same or like securities, in order that the same may accumulate at compound interest until the fund so formed amounts to the prescribed sum, or if no sum be prescribed a sum equal to one-tenth of the nominal capital of the undertakers, which sum shall form a reserve fund to answer any deficiency which may at any time happen in the amount of divisible profits, or to meet any extraordinary claim or demand which may at any time arise against the undertakers; and if such fund be at any time reduced, it may thereafter be again restored to the said sum, and so from time to time as often as such reduction shall happen."

Section 33 provides that when the reserve fund is full, the interest thereon shall be dealt with as part of the profits of the undertaking.

Section 34 provides that the reserve fund may be used to supplement the profits in any year where sufficient has not been earned to provide the prescribed rate of dividend.

Section 35 provides that if there be any profit in excess of what is required to pay the prescribed dividend, and if the whole of the reserve fund has been, and remains, invested, that the price of gas shall then be reduced, &c.

It is quite clear, from the above, that the establishment of a reserve fund has been sanctioned, if not prescribed, by the legislature, and that all gas companies with statutory powers are entitled, if they think proper, to fill up their reserve fund *before reducing the price of gas.*

In practice. however, this is not commonly done, and very few companies have any reserve fund at all within in the meaning of the Act—*i.e*, *properly invested.* In most cases, undivided profits are invested in extension of the works and plant, and are made to do the work of capital to the great benefit of the consumers.

But having regard to the fact that circumstances may arise at any time which may make it advisable or necessary for a gas company to part with their undertaking to a local authority, I wish to point out that it is the interest of all gas companies, before unduly reducing the price of gas, to fill up their reserve funds, to have their plant in the highest state of efficiency, and to keep their accounts in the clearest manner.

It is useless to attempt to hide the fact that, from various causes, the control of gas and water works is passing into the hands of public bodies, and it is well that the matter be looked at full in the face, that all parties should understand how their interests will be affected, and how those interests may be best protected.

By the introduction of "auction clauses" into all gas bills, and the extinction thereby of the rights of shareholders to take new capital at par, their interest in maintaining possession of their undertakings has been sensibly weakened, and, consequently, there is no reason to suppose that the process of "transfer," which has already assumed such formidable proportions, will have less force in the future than it has had in the past.

So far as the interests are concerned of the gentlemen whom I have now the honor to address, I fear they may not be better off under the new *regime* than under the existing one, but it is possible that the gas consumers may find themselves anything but benefited by the change.

The result of many recent arbitrations to settle the value of gas undertakings has been conclusively to show that a gas company, earning full statutory dividends, will obtain not less than 25 years purchase of same; in other words, that the purchasing body will be able only to get 4 per cent. upon the purchase-money of the existing business.

In some recent cases of transfer, where there has been an invested reserve fund, it has been, by arrangement, retained by the sellers, and as the ambition of the local authority purchasing is usually to show a large profit on the working of the concern, the experience in the past has been that this result is arrived at, for the most part, by maintaining the price of gas at a higher level than would have been possible, or necessary, if the undertaking had remained in the hands of a company controlled in their operations by section 35 of the Gas Works Clauses Act, the restrictions contained in which have never yet been imposed upon a public body having authority to supply gas, who are at liberty to make any profit they can, so long as they charge no higher price for gas than the maximum price named in their Act, or in that of the company of whose undertaking they have become possessed.

It is quite clear, therefore, that gas consumers may, by this means, be taxed for the benefit of those ratepayers who are not gas consumers.

The foregoing observations are principally directed to the case of those gas companies having statutory powers; but there are many instances of local boards, in growing districts, attempting to acquire the control of the gas supply in their respective localities, where the gas company are not protected by a special Act.

I need hardly point out that in such cases the non-statutory company are at a great disadvantage, and, in fact, have no option but at once to go to Parliament for an Act of Incorporation, because, under the powers of the Public Health Act, 1875, section 161, any urban authority, where there is no company or person *authorized by Parliament* to supply gas for public or private purposes, may themselves undertake the supply of gas throughout the whole or any part of their district; that is to say, a non-statutory company whose operations are not protected by a special Act or by a Provisional Order, confirmed by Parliament, are very much at the mercy of the local authority desiring to acquire the gas undertaking.

Very exaggerated notions of the burthens which the cost of an Act would entail upon a small company prevail, but experience has shown that the benefits far outweigh the cost.

There are numerous companies, with a sale of from 6 to 12 millions, without statutory powers. If a special Act cost say £800, taking the sale of the smaller quantity, the cost of the Act would only entail an additional charge of about 1½d. per 1000 cubic feet, and for the larger quantity about ¾d., while the possession of the Act will not only be a source of strength in dealing with the local authority—the operations being protected by statute—but will absolutely enhance the value of the undertaking for sale, to a greater extent than the sum expended in obtaining it.

I therefore strongly advise small companies *without* statutory powers seriously to consider this question in connection with the subject of probable or possible transfers in the future, and to protect their property in the way I have indicated.

I will now bring this paper to a close, and while I am quite sensible that the information it contains is already well known to many gentlemen now present, yet there are doubtless others to whom it may be useful.

I have no other motive in bringing before the meeting the subject of this paper except that I may add my mite to the mass of valuable information which has been gradually accumulating since this Association has been established, and will only say, in conclusion, that whether the gas works of Great Britain remain in the hands of private companies, or pass into the possession of public bodies, it is quite certain that there will never be a lack of able and honorable men, with the necessary scientific knowledge and skill, to carry them on with advantage to the public and credit to themselves.

Mr. H. P. Stephenson said it was very curious that in the parliamentary arrangements made with regard to gas companies, the authorities were very careful that in gas companies bills stringent clauses should be inserted, defining very exactly the powers conferred; but when public bodies themselves went to Parliament they never said anything whatever about these things. They seemed to think they were such virtuous, honest individuals that all these matters might be left to their own honor. What struck him in connection with the paper just read was this—that, if some small companies went to Parliament to get an Act, with a view to afterwards transferring their undertakings to the local authorities, they might have such disagreeable provisions included in their Acts that the local authorities would not have anything whatever to do with them.

Mr. Sheppard (Horsham) said there was one point which might affect the interest of many members present. It would be found in the Public Health Act that, when a local governing body purchased a statutory company, they were required to make remuneration to the officers. He would, therefore, suggest to those present, if they happened to belong to non-statutory companies, that they should use every endeavor to induce their directors and shareholders to get incorporated.

Mr. Storer (Stafford) desired to thank Mr. Penny for his admirable paper, and only regretted that it had not been read several years ago. Had it been, it would have given information to many gas managers, which would have proved very useful to them. Had his company possessed the information some years ago which he had been in possession of some few months, the Stafford Gas Works would never have been transferred to the corporation at the price they were, although the price obtained was nearly 30 years purchase of the dividend; and it was a compulsory sale too, which was about as high a price as that of any gas works which had been transferred. Looking at the tendency of things in the present day, he would advise his brethren to put their houses in order, and have all the apparatus connected with their works thoroughly up to the mark; to let everything be done as well as it possibly could be done; to fill up the reserve fund; and, amongst other things, if the corporation had not already an Act by which they had power to purchase the works, to carefully watch that Act when it was being obtained. The Act at Stafford, under which the corporation obtained the power, was unfortunately not watched. He could not say whose fault it was, because the party was not present; the consequence was, a clause was inserted which was never noticed until about a week ago, the effect of which was that the whole of the purchase money must be equally and rateably divided amongt the shareholders, without any provision being made for the compensation of directors or officers. The transfer did not take place without going to arbitration. Some of the most eminent men of the day examined the works, and under the arbitration certain awards were made. Amongst other things, were certain sums alloted for the secretary and for directors; but he was sorry to say that, in consequence of the clause mentioned, all those allowances had vanished, and the directors found themselves obliged to pay over every penny of the purchase money to the shareholders. Fortunately it was discovered that the company had not paid their full dividends for a certain time, and they were able to capitalize the interest on the debenture stock which had been borrowed at from 4½ to 8 per cent., or else they would have been handed over, tied hand and foot, at 25 years purchase.

Mr. Carr (Halifax) rather regretted the tone that some of those discussions took with regard to corporations. He had made a similar remark at the last meeting, and as so many members of the Association represented corporations, it was only fair that some one should take the corporation side in these question He for one thought a great deal more was said about corporations than was altogether justified. Of course there were some corporations whom no one admired, and, judging by the way in which some companies rewarded their servants, none of them would like to be in similar institutions. But he had had experience of some companies who did not do exactly as they ought to do, or as they considered a company ought to do, just as there were some corporations who did not exactly do what they would like. It struck him that if the members of the Association were to follow out the President's suggestion, and make a report to their respective committees when they went back, and had to state that the meeting had been engaged in pitching into corporations, and showing them up in the most deplorable light, these bodies might be induced to reconsider the question whether they would allow their engineers to come to these meetings. He was quite sure that many of these reports got into the hands of corporations, and he could not think that the members of those bodies who read them would be favorably impressed by what they read as coming from the mouths of their servants when they assembled together. Some gentlemen objected to his remarks, but he was not speaking so much about anything which had been said that day, but was rather drawing

a strong case of what he desired to avoid. He thought they should try to make the Association as representative as possible, not of gas companies, but of the engineering profession; and he was sorry to see that the *Journal of Gas-Lighting* took a one-sided view of this matter—even going the length of questioning whether any man of honor could serve a corporation. He thought those remarks were to be deplored. They did not improve the position of those gentlemen who did serve corporations, and he was quite sure they did harm.

The PRESIDENT, interposing, said the discussion of remarks which appeared in the *Journal of Gas-Lighting* was hardly pertinent to the question.

Mr. CARR said he would, of course, bow to the decision of the chairman. There was one or two remarks in the paper which seemed to him rather contradictory. One was that gas companies invariably did the best they could, independent of any pecuniary benefit it might be to the consumers. Then, in deploring the action of auction clauses, Mr. Penny went on to say that the effect was to take away any pecuniary benefit the company might have from the proper regulation of their business. These two things did not go very well together. He was not exactly of the opinion expressed with regard to the auction clauses. He though 10 per cent. was a very high sum to be guaranteed by Parliament as the return for money *to be* invested, though it was not at all too high for money which had been invested under risks which did not now exist. Seeing that the risks had all been removed by Parliament, he did not see that so high an interest was required for money which had to be invested in future.

Mr. HELPS (Bath) said they must all be thankful to Mr. Penny for his interesting paper regarding the transfer of gas works to corporations. He would suggest that some member should read a paper next year on the other side of the question- namely, the transfer of gas works from corporations to companies.

Mr. WOODALL (Leeds) said he had occupied for some time the exceptional position of being in favor of the transfer of gas works to corporations. At Leeds the corporation were doing all that any company could be supposed to do in the interest of the gas consumer, and the line of policy they pursued was the very opposite to that which corporations ordinarily followed. When he went to Leeds he found a deficit of something like $20,000, due from the gas undertakings to the borough fund, and until they had paid that, the corporation did not feel justified in dealing with the profits as belonging to the consumers. But that amount once paid off, he propounded the principle of "gas profits for gas consumers," and, somewhat to his surprise, he had very little difficulty in permeating the whole corporation with his view on the subject. From that time the committee has gone to the extreme in that direction. They did not even wait for a balance in order to be assured that they might sell gas at a lower price in the year following, but they anticipated the balance which was to accrue, supposing the price were maintained, and he had his instructions each year to prepare an estimate in such a way that no balance should remain. In fact, it would be best work on his part to make the income and expenditure exactly balance, and not allow of one penny being paid even for income tax. But while he favored this principle of the transfer to corporations, he did not see that much good could result to any parties, now that auction clauses were introduced into all new Acts, because under the auction clauses, a company would in future erect additional works at a cost of 5 per cent., whereas a corporation must pay 4 or $4\frac{1}{4}$, or perhaps $4\frac{3}{4}$ per cent. for money they required to raise; and they must put by, for a sinking fund, perhaps 1 per cent., so that the charge for the future gas business of corporations would be quite as large as if the business were managed by companies.

Mr. PENNY said there was not a great deal to reply to. Mr. Woodall had made some opposite remarks; but he though the line of conduct adopted by the corporation of Leeds was an exception to the rule. His own opinion was that, when local authorities acquired gas works, they did it with a view of obtaining profits for some general purpose. No doubt the idea was that it would be a benefit to the township: but as it happened, the profits so obtained were provided by the gas consumers, so that those who were not gas consumers received a benefit they were not entitled to. However this might be, he did not consider that his observations on local authorities and corporations were obnoxious to the remarks made by Mr. Carr. This gentleman overlooked the fact that local authorities first attacked gas companies, with a view to get possession of their property. He (Mr. Penny) had certainly not said much to the detriment of corporations in respect of their conduct of gas undertakings; but, all the same, he believed their management was not superior to that of the companies whom they superseded, nor did he think, if his paper were read carefully, it would be considered by corporations that their officers had been placed in a false or improper position by merely listening to its contents. What Mr. Storer had said was much to the point—viz., that it was necessary for gas companies, and those who advised them, to be very careful in the conduct of their operations, having regard to what might possibly happen. The mischief in Mr. Storer's particular case was done long before the arbitration commenced, and could not be undone by those acting for the company at the time the arbitration was being held. So far as he could gather, those whose duty it was to watch the Stafford Corporation Bill watched it at a distance, and so did not see those obnoxious clauses which bore so hardly on the officers of the Stafford Gas Company. There was no doubt that when a gas company where about to be transferred, it was advisable, if possible, that the interests of those who had been serving them so many years should be studied. He should, therefore, strongly recommend the directors and officers of gas companies, when a transfer of their undertaking was in contemplation, not to wait until the mischief was done, but at once consult those competent to advise them, who were constantly engaged in parliamentary business, and knew what the meaning of those little clauses were, which appeared simple in themselves, but which sometimes had very serious consequences when they came to be inquired into and acted upon.

The PRESIDENT, in closing the discussion, said he was quite sure the whole body of members would support Mr. Carr in the observations he had made, but he was not aware that, either in the present discussion or any other when he had been present, anything had been uttered to which exception could be taken.

Mr. GEORGE LIVESEY read the following paper on

CAPITAL AND REVENUE.

"The Proportionate Capacity of Apparatus and Standards for Capital and Ezpenditure" is one of the suggested titles for a paper, and although it appears a practical subject, it will probably be found, on further consideration, and exceedingly difficult one to deal with satisfactorily. The first part, relating to the proportionate capacity of apparatus, would probably be answered in the best manner if a return could be obtained from a sufficient number of the members of the Association to be fully representative of all the varied circumstances under which gas undertakings exist, setting forth the capacity and the cost of construction of the retort houses, condensers, washers, scrubbers, purifiers, gas-holders and mains. An individual can give only his own experience, which certainly could not be accepted as a reliable standard for gas works, seeing that no two can be exactly alike.

In reference to capital, which is the chief subject of this paper, it ought to be possible to find a maximum standard, in proportion to gas producing power, which shall be capable of application to all except the smallest works.

The relation of capital to revenue is, in principle, a simple matter, but in our business it is complicated by such a variety of circumstances and interests that a great confusion of opinion and of practice has resulted.

Capital may be defined as money represented by productive works, or used in working a business; there is a vast amount of so-called capital which is unfortunately represented by nothing at all. To begin with, we have the National Debt, which represents nothing but the good faith of the country, and its ability to pay, not its debt, but merely the interest; but the debt is not capital representing actual property. Again, there is an enormous amount which goes by the name of capital, although it stands for nothing but money spent in fruitless contests, in waste of various kinds, mistakes and extravagance on works that are obsolete or worn out, and on works that now have no existence.

This does not apply to gas works merely, but to railways, docks, water works, and to joint-stock enterprises generally. So long as a concern is able to pay interest on its nominal capital, it is assumed that the capital is represented, and it has a market value; but I hold that the only sound position is that the works and plant should be fully worth, at all times, the sum charged against them in the capital account. It is quite true that capital may, nay, must be expended, and with perfect fairness on other things than plant. For instance, the cost of an Act of Parliament, or the *legitimate* expenses attending the starting of an undertaking, or the amount paid for a foreign concession, are all proper charges on capital; but a sinking fund must be provided out of revenue to liquidate the cost of the concession by the time that it expires. Preliminary expenses should also be written off as soon as possible, and even the cost of an Act of Parliament. Although the powers conferred by it may be exceedingly valuable,, present and prospective, still, changes being possible that may render an Act of Parliament valueless, the capital account should be cleared of this chaege also, in order ultimately to attain the position of having every penny of capital fully represented by the structural value of productive works.

This may be said to be a mere truism, and in the case of the individual millowner, manufacturer, or shipowner, it must be accepted and acted upon, or he will sooner or later find himself in difficulties. The principle is recognized and put into practice by the great steamship companies, and there is, I suppose, at least one English gas company, whose works are all on the Continent, and one or two companies with works in England, where the value of the plant *exceeds* the amount of the paid up capital. But these are exceptional cases, and not recommended for imitation; they are sacrificing, to some extent, the interests of the existing shareholders for the benefit of posterity, or for the public body that may purchase their undertaking. They have, however, as yet, found scarcely any imitators, the overwhelming majority erring in the opposite direction at the expense of future generations of shareholders or of the public authorities who may be tempted to purchase.

In many cases the disparity between the value of the works and the interest bearing capital would, if the business were not of an exceptional character, be simply ruinous. Where would an ordinary manufacturer, exposed to fair competition, find himself if his plant for making a certain article had cost just double as much as other makers had expended on similar plant? The question needs no answer.

Having made the statement that gas undertakings generally have a larger capital than is represented by works, it is necessary to bring evidence in support of it, and to name a standard of capital in proportion to gas producing power that shall be fairly applicable to all ordinary cases, and allow a good margin for unforseen contingencies. The margin will be somewhat greater in large works, but not so much greater as would appear at first sight. For instance, a retort-house to enclose ten retorts would probably cost less in proportion to the number of the retorts than one to cover 200, seeing that the walls of the small house will be less than half the height and thickness of the

large one, and the roof also will cost less. On the other hand, small gasholders cost more in proportion than large ones.

Four years ago, in this room, I said that the capital expenditure might, in most cases, be kept within £5 per ton of coals used in the year. I am now prepared to say that where the capital exceeds £5 per ton, or, say, 11s. per 1000 feet of gas sold, the capital is greater than the value of the works, mains, and working capital. It is better, perhaps, to take as the unit the 1000 feet sold, rather than the ton of coals used; but if we assume that the unaccounted-for gas does not exceed 10 per cent.—it should be well within that figure—the ton of coals will stand for 9000 feet of gas sold. These terms are easily convertible by dividing the amount per ton by nine; and so, for convenience and simplicity, I shall take the ton of coals as the unit.

Of the total capital, if a company pay all their accounts in cash when the goods are delivered, nearly 10 per cent., but not exceeding that amount, will be required for working capital; this leaves £4 10s. per ton for plant. It is generally agreed that of the capital expended, about two-thirds will be laid out on the works and land, and one-third on mains, meters, and services. By this rule we obtain out of the £5—

Works per ton of coal	£3 0 0
Mains, &c., outside the works	1 10 0
Working capital	0 10 0
Total	£5 0 0

Or at per 1000 feet sold it will be—

Works	£0 6 8
Mains, &c	0 3 4
Working capital, about	0 1 0
Total	£0 11 0

This statement is based on my own experience in the construction and valuation of works. It is supported by that of eminent engineers with whose work I have become acquainted, who have exceeded in economy, without sacrificing efficiency, anything that I have done.

The item of £1 10s. per ton, or 3s. 4d. per 1000 feet sold, for the outside plant, does not require detailed evidense to prove its sufficiency. I, therefore, proceed to sustain my assertion that £3 per ton, or 6s. 8d. per 1000 feet sold, as applied to the cost of works and land is sufficient, by the following actual cases, the names only being withheld.

It is not contended that the capital account should be exactly divided as above indicated. All that I wish to maintain is, that the £5 per ton, or 11s. per 1000 feet sold, is a sufficient maximum capital for all but very small works.

Case No. 1.—Small works in Yorkshire, complete in every respect, and capable—with a margin of at least 15 per cent. of retorts out of use in the depth of Winter—of carbonizing 16 tons of coal per day, or 3200 per annum—say, 3000 tons—which, with a total cost of works and lands of £8420, gives £2 16s. per ton of coal, or 6s. 3d. per 1000 feet sold.

Case No. 2.—New works on new site, to replace old worn-out works in a cheap district—North of England. The company with a heavy capital, and very little to show for it, necessitating great economy. With a little correction, these works can be taken as capable of using 100 tons of coals per day, or 20,000 tons per year; but taking them as constructed, there is a retort-house, to contain retorts sufficient to carbonize 125 tons per day, and to allow more than 10 per cent. out of use. Condensers, exhausters, purifiers, scrubbers, and meter for 100 tons, or 1,600,000 feet per day. Gasholder storage, 500,000 feet. Cost, inclusive of six acres of land complete, £23,600. Coals used in the year, 9000 tons, equal to £2 12s. 5d. of capital per ton of coal, or 4s. 9d. per 1000 feet sold.

But, by adding another gasholder for 500,000 feet, and setting some additional retorts, the capacity of the works will be brought up to 100 tons per day, or 20,000 tons per year. For these addition works, I dd, as the outside cost, £11,000, which is more than they would amount to at the rates at which the other work was executed.

The total, therefore, for 20,000 tons per year will be £34,600, equal to £1 14s. 7d. of capital for each ton of coal used in the year, or less than 4s. per 1000 feet sold.

Case No. 3.—Some entirely new works, not 100 miles from this place, erected as an additional station for a large company, calculated to make 3,000,000 a day, corresponding with a consumption of 60,000 tons of coal per annum. Cost complete, with a large plot of land, very little over £100,000, or well within £2 per ton of coal, or 4s. 6d. per 1000 sold.

It is right to add that cases 1 and 2 are in cheap districts, No. 1 being erected at the time when prices were rising, No. 2 in cheap times, and case No. 3 is not in a cheap district; but the work was done, and done thoroughly well, when prices were low.

Case No. 4 is that of a large company where a large area of land was purchased, some ten or twelve years ago, adjoining the works on which the extensions have been made. This company have, I know, charged to capital, during the past 12 or 15 years, a sufficient sum to pay for all the outlay on land, works, mains, meters, &c., to meet the requirements of a business that rather more than doubles every ten years, with the result that the proportion of capital to coals used has remained stationary at about £4 15s. of capital to the ton of coal. At the same time the price charged for gas by this company has, during the whole period, been lower than any of their neighbors. A very large proportion of the additional work was executed during those late years of excessive prices, and the surplus power of the works has been very considerably increased. The gasholder capacity, in 1866, was less than 80 per cent. of the maximum make, and in 1877 it was 115 per cent., while the retort power, with the other portions of the plant, has been increased to a corresponding extent beyond the proportions of ten or twelve years ago.

I do not say that the cost of the works, as set forth in cases 1, 2 and 3, is to be taken as a standard, for I consider that any standard should be based on average prices and circumstances; but these cases, taken in conjunction with case No. 4, fully warrant me in saying that £5 per ton, or 11s. per 1000 feet sold, is a sum that ought not, in any case, for new works, except the very smallest, to be exceeded. Whether or not it is necessary or desirable in all cases to make the effort to reduce existing capitals to this level is not my business to decide. It is a complicated question, and must be settled by those immediately concerned. I only say that any capital, exceeding this standard, is not represented by works.

That capitals generally exceed this limit is an undoubted fact: but, in order not to appear invidious, I take the London companies as an example.

In 1861, when the first parliamentary return was made, the aggregate capital of the 13 London companies was £5,647,899, and the coals used did not exceed, but nearly approached to 644,000 tons. I cannot obtain exact figares, but know that this may be taken as sufficiently correct. This works out to close upon £9 of capital per ton.

In 1869 the capital, share and loan, amounted to £7,828,844, and the coals to 1,171,588 tons, which gives £6 13s. 8d. per ton, the highest amount of capital being £8 7s. 4d., and the lowest £4 10s. 6d., three of the 13 companies being below the £5 standard.

This shows a very great and commendable improvement, and it shows, moreover, what may be done in the reduction of capital.

In 1877, another interval of eight years, we find only six companies. The total capital amounted to £11,845,749, and the coals used to 1,614,246 tons, or £7 6s. 11d. per ton, the highest being £8 0s. 2d., and the lowest £4 15s. 8d., only one of the three companies, with capitals below £5 per ton being left, the other two having been amalgamated.

During this last interval, a great increase has taken place in the capital account of some of the companies while that of others has been very considerably reduced. The increase is accounted for by the gigantic works that have been erected, and has, therefore, to some extent, been unavoidable; but it ought to be reduced from year to year, as these works come more and more into use.

Notwithstanding all these variations in the capitals, the course of the companies has been one of almost uniform prosperity, and the question naturally arises, How is it that these undertakings should be so prosperous? Either the principle laid down in this paper is altogether wrong, or there is something extraordinary in the circumstances under which gas companies exist.

Some will at once say that it is all owing to the absence of competition, which is, in a sense, correct; but if the inquiry is carried somewhat further, it will be found that the defective legislation, which has been brought to bear on the companies from outside, by those who wished to exercise control over them, has the most to answer for.

The legislation controlling gas companies was framed in the days when competition was universal. I refer to the general Act of 1847, which was, for those circumstances, an exceedingly good and just Act, both for the public and the companies: but when the circumstances had entirely changed, by the complete abolition of competition, this Act, in its relation to capital and dividend, became obsolete. This the authorities did not see, and in the Metropolis Gas Act, 1860, they incorporated and reaffirmed, with some slight imitations as to back dividends, the 1847 Act. That it was a great mistake is, I consider, amply proved by the widespread and almost continual discontent which the public authorities have shown since 1860 toward the London gas companies, which dissatisfaction has been reflected in the provinces, resulting in endless inquiries in Parliament, which produced, after a three years contest, the Act of 1868, providing a power of revision. The notorious provision clauses utterly failed to give satisfaction; the discontent they produced leading to another protracted inquiry, which led, in 1875–6, to the adoption of the principle of the sliding scale, advocated by the writer before this Association in 1874. This was, at the time, vehemently opposed by the companies, who allowed the right opportunity for its adoption to pass; but, after twelve months consideration, they effected a treaty of peace with the authorities on that basis, and were compelled to accept the auction clauses, which I did not recommend, and, as a gas shareholder, do not like, but against which I cannot argue, for I consider them a just arrangement under the circumstances of non-competition in which gas companies are placed.

So far the sliding scale has worked satisfactorily; the public have not grumbled, but have rather commended the increased dividend that has, in one or two instances, been paid in London. I hope and believe that the companies—who now express their satisfaction with the sliding scale—if bad times come, necessitating a reduction of dividend, will cheerfully acquiesce, for it is simple justice that producer and consumer should share in fair proportions the advantages of prosperity and losses of adversity.

The old legislation designed for competition, but continued after it was abolished, made it difficult to do right, and easy to do wrong in reference to capital; but now there is no excuse, thanks to the valuable tables compiled annually by Mr. Field, to legislation on sound principles, and to the light thrown on the question by the numerous public inquires into the matter.

There is, however, ample justification for the excessive capitals of the companies. *They* did not create the legislation, it was forced upon them by Parliament; *they* did not create a state of competition, it was forced upon them, in most, if not all cases, by the consumers: therefore the companies cannot be blamed for the natural result of Acts not their own, nor for reducing their capital by extending their works out of revenue.

Lest the advocates for competition should think that a return to it would be beneficial, let me say that

it was the cause of a greater amount of waste and loss, both on capital and revenue account, than any other circumstances affecting gas companies—a waste and loss which ultimately fell upon the consumer, and to this objection to competition must be added the immense public inconvenience that resulted from the multiplication of mains in the streets. Competition is utterly out of the question; it is a system most expensive to the consumer, while it is ruinous to the gas company.

There is, however, one serious objection to a small capital In these days, when scarcely a week passes without a report of a gas company having been purchased by the local authority, which fate stares all the rest in the face, it is but natural that the question of a reduction of capital should be looked at in reference to its effect on the probable terms of purchase. It is the fact that, with purchase in view, it is a positive and great disadvantage to a company to reduce their capital. The rule is, not to take as the basis of purchase the intrinsic value of the concern, but only the amount of dividends paid. I will put a hypothetical case:

Company No. 1 sell 100 millions a year, and have for this purpose the moderate capital of, say, £50,000 (a trifle below the standard of £5 per ton); they divide amongst shareholders, at 10 per cent., £5000 a year, and the price they would receive from a purchasing authority would be, at 25 years purchase, £125,000.

Company No. 2 also sell 100 millions, but have the extravagant capital of £100,000, or nearly £10 per ton of coal; the dividend amounts to £10,000 a year at 10 per cent., for which they would receive £250,000, or double the amount of No. 1, or even if half the capital was at 7 per cent. they would then receive as dividend £8500, and as purchase-money £212,500, against £125,000 in the other case.

Where is the justice of this, and how can any gas company be expected to exercise such a high standard of exalted virtue as to reduce their capital when purchase on this system is in view? It may be thought that my illustration is much exaggerated. but such is not the case. A transfer has just been effected under the following circumstances: The company's able manager has for years been working with the view to reduce the capital to a thoroughly sound basis, and has succeeded in bringing it well within the £5 limit, and in getting in addition a large excess of plant. The counsel employed to conduct the case before the Arbitrators was unable to secure more than the usual terms, although if the capital account had been run up to £7 or £8 per ton, the share-holders would have received half as much again for the very same property.

What, then, is to be done? Parliament has, in a measure, caused, and has undoubtedly sanctioned, the past expenditure on capital. It may be wise to reduce this, and it is quite fair to effect the reduction out of revenue, but as to future expenditure on capital account there ought to be no doubt.

Capital may be lost by the construction of more expensive works than are necessary; and that there is a tendency in this direction there can be no doubt. Human nature likes grand things, and committees of town councils, with the rates, as they say, behind them, as well as boards of directors, are not free from this infirmity. They are frequently carried away by an imposing appearance, when something much more simple and less expensive, while equally good, would answer the purpose. Contractors and manufacturers naturally throw their influence into the scale in favor of expensive plant, and I can find no fault with them for doing so, except with those who find in it a larger margin for the exercise of the bribery to which some of them owe a large portion of their business, as one who signed himself a "Commission Abolitionist," in a letter he addressed to *The Times*, confessed that he had made his business, to a great extent, by this system, and then endeavored anonymously to kick over the ladder by which he had mounted to prosperity, and at the same time to destroy the reputations of all connected with gas works.

Engineers and managers also have a laudable desire to make their works as substantial and good-looking as possible; but this often leads to loss of capital in needlessly expensive constructions. I do not by any means advocate anything paltry or shabby, but I believe that gas-works that are soundly, but not too substantially, constructed, well proportioned, and with an evident fitness for the purpose for which they are intended, without any direct attempt at ornamentation, and with economy apparent in every feature, will look when in use, and the dirt and smoke have had time to take effect, infinitely better than those highly ornate constructions that have such a fascination for some people. To my mind, this high art, as it may be styled, is out of place in gas-works, which, when placed in a suitable position, are scarcely ever seen, and, if seen, are not likely to be admired, except when quite new and clean.

Let it, then, be our object to produce the greatest effect with the smallest expenditure. A lavish expenditure may, in one sense, be a benefit to some, but economy and care on the part of each or any section of the community is the only way to create lasting prosperity.

A word as to revenue. In these times, when all traders are complaining, gas undertakings still find their revenue maintained. It is, however, their duty to make a right use of it; they are, in fact, bound, by the common bond of duty to the community, to exercise care and judgment in the appropriation of revenue; and to us, as gas managers, it is highly important that we should give our attention to this question as well as to that of capital.

Taking the gross revenue, which we will assume is carefully collected, and that the most has been made of all the sources from which it is derived, and first charge upon it is to pay for the materials and labor required in the ordinary working of the business; the second is the annual expenditure of so much of it as is sufficient to maintain the works and plant in thorough good order at the full capital value. Where portions of the plant have become obsolete or worn out, they should be renewed out of the revenue, and in cases where apparatus of increased size is erected to replace that which is used up, only the cost of the additional gas-producing power should be charged to capital, the rest being borne by revenue. It seems almost waste of time to insist on such a self-evident principle, but it is necessary, because it is a very common practice to charge the whole cost of renewals to capital, and where new works are erected this is almost the universal rule. I suppose because the value or the original cost of the adandoned works is too great to be taken from revenue in any year; but where this is the case, a sinking fund ought to be established, writing off from revenue a fixed sum yearly until the whole is liquidated in a reasonable time. It should be remembered that after the new works are erected, the charge for repairs for some years will be merely nominal; it would therefore be fair and right to charge against revenue the full normal amount for repair and maintenance, and thus reduce the capital by writing off something every year; or, if this cannot be done, by paying the cost of additional plant and extensions from revenue.

In the appropriation of revenue for the maintenance of works, there would be no difficulty if a fixed and certain sum each year were required; but it sometimes happens that a very large sum is required in a single year, as, for instance, when a gasholder has to be renewed, or a large gasholder must be erected in the place of a smaller one. The renewal is a charge that should be entirely borne by revenue, and, in the other case, out of the total cost of the gasholder, so much should be charged to revenue as will represent the original value of the small holder. Supposing a small holder cost £3,000, and in its place a larger one is erected, costing £10,000, of this sum £7,000 is chargeable to capital, and £3,000 to revenue.

Unfortunately, the various Acts of Parliament provide no depreciation-fund for meeting such cases; consequently it very commonly happens that the whole £10,000 is charged to capital, thus making the accounts show £13,000 as the amount expended on this gasholder, while it is only worth £10,000. The creation of a suspense account, to liquidate the £3,000, would, under these circumstances, be a proper thing to do. Anything, in fact, being better than to allow the £3,000 to stand as part of the capital, with nothing to show for it; but suspense accounts should, if possible, be avoided.

The Gas-Works Clauses Acts provide that, after paying full dividends, and filling up the reserve-fund, all further profits shall go to the consumers, in the shape of a reduction in the price of gas, overlooking entirely the necessity for a depreciation-fund, or a maintenance-fund, which should be the first object of attention.

The only suggestion I am able to make is that, after filling up the reserve-fund, a moderate surplus should be gradually accumulated and carried forward from year to year as an undivided balance. I do not think any objection could be taken to this course, provided the balance did not assume unreasonable proportions. That an objection would be taken is most unlikely, seeing that any action by the Authorities, under the act of 1847, is rarely, if ever, undertaken to compel a reduction of price. Such action, against such a fund, accumulated honestly for the purpose herein indicated, would now be far less likely than before, seeing that recent legislation leaves the undivided balance perfectly free. I could give instances where the undivided balance has been of the greatest benefit to both Companies and Consumers, providing a fund for the former out of which to meet any extraordinary charge, which must otherwise have been met by an increase in the price of gas. I say, therefore, provide such a fund in advance, out of which to pay the charges for abnormal repairs.

The last charge upon revenue is the dividend. The expenditure on the ordinary working, together with that on repairs and on the sinking-fund, when necessary, having been deducted from the gross revenue, the balance only, whatever that may be, is available for dividend, any remainder going to form a reserve-fund. If the principles enunciated here are acted upon, there will be but little fear that, under any conceivable circumstances, the net revenue will be insufficient for this purpose, but I can conceive circumstances in which, if sound principles are neglected in prosperous times, the dividends may not only be seriously reduced, but destroyed. We have no right, because circumstances are in our favor, to neglect those principles on which alone a sound business can be founded; those principles must be maintained against mere expediency, and they will, in the end, be found to work the greatest good for the greatest number.

In conclusion, I must ask you to forgive any apparent dogmatism in this paper. I have no desire whatever to force my opinions upon you, although, when called upon, I am bound to express them. If they are unsound, I shall be glad if you will refute them; but if they are right, I hope they will be generally adopted, and that, in adopting them, increased prosperity may result to the Members of the British Gas Managers Association.

[To be continued.]

On the Subject of Gas Leakage.—Mr. Woodhall, gas engineer to the borough of Leeds, says:—"The unaccounted-for-gas in Leeds is 15½ per cent. over 500 miles of mains, about 80,000 service pipes, and 60,000 meters. The length of mains and other items enumerated are greater in proportion to the sale of gas in Leeds than in any town I am aware of in England. In Manchester and Birmingham, for instance, to about the same length of mains and the same number of meters, there is fully double the consumption.—*Ironmonger*.

Correspondence

[Correspondents, in all cases, should sign their communications with their names and address in full—not for publication, unless desired, but as a guarantee of good faith.—Ed.

[Special Correspondence of the Amer. Gas-Light Journal.]

Gas Notes From Ohio.

Columbus, Aug. 18, 1878.

Gas items in the West are not as plentiful just now as snakes are proverbially said to be in blackberry times. From here and there, however, I hear a spasmodic, jerky howl about the "thieving, stealing, cheating, swindling, corrupt gas monopolies." I never heard a good word said about a gas company in my life. It isn't the fashion to speak well of a gas company. I firmly believe that if some courageous individual would venture to state in a crowd that he knew of a gas company that was honest—that dealt honestly with its patrons—that he would be immediately seized upon, tarred and feathered, and banished outside the corporation line. It is one of the incongruities of human nature for people to condemn the most that which they know the least about; at least, such is my observation. I have seen it in politics. A political opponent is eternally damned by men who never saw him in their lives, and are totally ignorant of his life and character. I have seen it in social life. The villanous tongue of gossipy slander is set to wagging, and the characters of men and women are blackened and befouled all over by people who are so ignorant of the party they talk about that they could not tell you whether his or her hair is red or black. I have seen it in the church. People who profess religion, and who should constantly have within their hearts a feeling of that "sweet charity" which "covereth a multitude of sins," have attacked with savage bitterness the religious life of some brother or sister of whose daily records they are as destitute of knowledge as their hearts are of that "touch of nature which makes the world kin." And it is the same way with gas companies. People who are so totally wanting in ordinary knowledge that they couldn't tell me, if asked the question, whether gas is made from coal or the residuum of a dead mule, will blatherskite and talk about the dishonesty and corruption of gas companies with a profundity of gab that would make old Socrates himself stand back abashed and hide his head under his toga for very shame of his great ignorance.

The number of men out here in the West who have "*positive*" knowledge of the *actual* cost of making coal gas in every known locality in the United States where the article is consumed, is large enough, if organized as an army, to overrun and "lick" Turkey and Russia combined in one day, or even to annihilate the innumerable tramps in this land of Liberty and Freedom in the short space of twenty-four hours—provided they didn't stop in their sanguinary proceedings to tell some one *just* how much to a cent it costs to make gas.

Impulse and motive are the great levers of life. In the act of any man, discover the motive, and you solve at once his honesty or dishonesty. Impulse is generally honest, but devilish unreliable. In the universal and everlasting cry about "gas monopolies," both motive and impulse are to be found. People are like sheep. Let one old cute and cunning ram at the head of the flock begin to bleat and cry bah! bah! and all the rams and lambs and ewes of the herd will immediately see the necessity of crying bah! too, without any reason for it other than that the intelligent odorous and shaggy old ram at the front commenced his howl.

I have seen this homely aphorism (if I may be allowed to apply the word to my assertions) beautifully elucidated on a crowded or "last discount day" in the offices of various gas companies in different cities. One consumer, with a little more cheek than the others, will elbow his way through the crowd regardless of the rights of those who precede him, and in a loud voice, and language not as sweet or choice as that used by David of old when he sang his rhythmical Psalms, will swear that his bill is incorrect; that he knows it is, "because his neighbor on the square below him didn't burn half so much gas, and has a d——n sight bigger family than he has." That "every bill is made out by guess work;" that "gas companies were got up on purpose to rob the people; are a thieving set; are robbers, extortioners," &c., &c.; that he knows its so "because his gas bill is $5, and it only ought to be $1." Then the gentlemen, having delivered himself of this weighty and Sam Wellerian argument, will crowd his way out, smiling complacently under the plaudits and the "that's so" of the persons around him, and imagines himself a hero. Immediately, the ram having bah-ed, the rest of the flock crowd up, and then a general bah-ing commences; and each and every consumer will tell the same story about his bill being bigger than his neighbor's, &c., though, perhaps, in a milder way. The old ram who spoke first has a motive, and that is to glorify himself before the crowd; to prove himself a bold, brave man, as it were, "not afraid of any d——d corporation," while the meeker sheep commence to bleat from impulse, being impelled by the talk of Old Ram, and speak simply because the ram did, not because they have a just complaint.

When a Councilman or Alderman takes his stand upon the floor of the council chamber, and proceeds to deliver himself about "the gas monopoly, the rights of the people, the over-burdened tax-payers," search for his motive. When a member of the Legislature arises from his seat, and, with one hand resting gracefully on the protruding portion of his person which is located under his coat tails, and the other holding aloft a hugh roll of manuscript, reads therefrom an argument (?) in favor of his bill "To Regulate the Price of Gas," search for his motive. When the ward bummer stands on the street corner and in billingsgate style harangues about gas monopolies, search for his motive.

With one and all the motive will be the same, and there is only one name for it—blackmail. Examine their palms, and they will be found to be itchings ones; devilishly so. The employees of gas companies undoubtedly make mistakes; but who does not? In the employ of gas companies will be found persons who are discourteous, impudent, and disagreeable; but this same kind of creatures, unfortunately, are found everywhere. The error of one employee, or the impudence of another, should not be the cause of a wholesale denunciation of one or all gas companies. I know that many of our gas companies have rigid rules as regards their consumers, and some that are unjust, and give good cause for complaint; but my observation is, (and I have had no small acquantance and knowledge of gas corporations), that in all their dealings with the public they use every effort possible to satisfy the great number of people with whom they come in contact, and are thoroughly honest in their business with consumers.

I believe that gas companies in general deal more honestly with their consumers than private business houses do with their customers.

Detraction is an enemy that all prosperous people or combinations have to fight. The ignorance that people in general have of the business of manufacturing gas, and the continual hue and cry against gas companies by blackmailing newspapers and blackmailing politicians, are the two principal causes of all their troubles with the public. The Sixth Annual Meeting of the American Gas Light Association, to be held in New York City, October 16, 17 and 18, will be well attended by members from the West.

The generous hospitality of the Cincinnati Gas-Light Company, under the direction of its efficient and genial President, Gen. A. Hickenlooper, at the meeting last year in Cincinnati, is pleasantly remembered by all who were in attendance. The papers read at that meeting were unusually instructive and interesting. It remains to be seen what kind of cheer and hospitality New York will offer her visitors. However, no one doubts what it will be.

I am informed that members in the West are preparing papers and articles on various subjects to be read at this meeting, that will bring up numerous new topics for debate.

These meetings, for interchange of thought, cannot help but be prolific of good, not only intellectually, but in establishing a feeling of good-fellowship among the representatives of the various gas companies of the United States. At such meetings our imperfections are pieced out with the thoughts of others.

Ubiquity.

The Western Gas Managers' Association.

A CALL FOR THE ORGANIZATION OF A WESTERN GAS MANAGERS' ASSOCIATION.

St. Louis, Mo., July 31, 1878.

J. O. King, Esq., Supt. and Engineer Gas-Light Company, Jacksonville, Ill.:—

Dear Sir:—The benefits accruing to Gas Managers and Engineers located in the Eastern States from the workings of the "New England Gas Managers' Association," are evidences to the undersigned of the necessity of founding such an organization in our Western country. The National Association has done incalculable good, but does not, in many respects, reach the requirements of Western Managers.

We respectfully request you to issue a circular or card calling a meeting of Gas Works Managers and Engineers in the Western States, to be held in St. Louis, Mo., upon the days of the 18th and 19th of September, 1878, for the purpose of organizing the "Western Gas Managers' Association." A cordial welcome will be extended to visitors by the Gas Managers of St. Louis.

Yours, very respectfully,

T. G. Lansden,
Eng. and Supt. St. Louis Gas Works.

Harry E. Clark,
Supt. Kansas City Gas Co.

J. C. Zabriski,
Eng. and Supt. Laclede Gas Co.

R. Spencer,
Sect. and Supt., Burlington, Iowa.

R. Woodmansee,
Supt., Davenport, Iowa.

Wm. Wallace,
Supt., Lafayette, Ind.

H. Stacy,
Eng. and Supt. Indianapolis Gas-Light Co.

Peter Coffey,
Supt. Peoria Gas-Light Co.

L. A. Hall,
Supt. Gas Works, Louisiana, Mo.

A. W. Littleton.
Supt. and Eng. Gas Works, Quincy, Ill.

Jacksonville, Ill., Aug. 20, 1878.

Messrs. T. G. Lansden, H. E. Clark, J. C. Zabriski, R. Spencer, and others:—

Gentlemen:—Your request that I should issue a circular or card calling together the Gas Managers and Engineers of the West, for the purpose of instituting a Western Association, reached me this morning. Feeling, as I do, the great benefits to be derived from such an organization, I most cheerfully comply with your request, and truly hope that all Managers and Engineers in the West will make extra efforts to meet with us on the 18th and 19th of September (as named in the request above), that the organization may be full and complete.

Very respectfully,

J. O. King.

Jacksonville, Ill., Aug. 21, 1878.

In accordance with the above, I earnestly request

NEWCASTLE AND PROVINCIAL GAS COALS.

THE UNDERSIGNED ARE PREPARED TO EXECUTE ORDERS FOR

NEWCASTLE COAL (NEW PELTON),

ALSO FOR THE BEST QUALITIES OF

PROVINCIAL GAS COAL,

DELIVERED AT ANY PORT IN THE UNITED STATES.

We supplied nearly 100,000 tons of Provincial Coal to some twenty-five different Gas Companies in 1877. These coals will yield in practical use fully

10,000 Cubic Feet of 16 1-2 Candle Gas---40 Bushels Coke.

JAMES D. PERKINS.
F. SEAVERNS.

PERKINS & CO.

45 SOUTH STREET, NEW YORK.

and hope that all Managers and Engineers of Western Gas Works will make special efforts to meet with us in St. Louis on the 18th and 19th of September, for the purpose specified in the above correspondence. The hour and place of meeting will be announced in the *Globe Democrat* of the 18th of September.

J. O. KING.
Supt. and Eng. Jacksonville Gas-Light and Coke Co.

The Oil Well at McKeesport, Pa.—The oil well at McKeesport, Pa., has reached third sand, and a great flow of gas resulted. All the drills were thrown out of the well, and it was impossible to proceed with the work. The gas makes a great noise as it escapes from the mouth of the well, and it can be heard at the town, which is three miles distant. Tubing was put down, conducting the gas some distance from the well, where it is burning, and at night illuminates the whole country for a great distance.—*Labor Tribune.*

Prices of Gas Coal.

Waverly Youghiogheny	5.25	
Moore's "	5.50	
Shafton	5.35	
Despard Marion	5.15	
Newburgh Orrel	@	3.85 at Baltimore.
Murphy Run	5.25	
Chesapeake and Ohio Agency Coal	5.25	4.00 at Richmond.
Newcastle	3.75 @ 3.85	
Provincial	4.15 @ 4.50	
Cannelton Cannel	10.00	
Ince Hall	8.00	

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The party applying must be a practical man, acquainted with gas making in all its details. Application, with testimonials, to be forwarded on or before 20th Sept. next, to

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We would solicit an order, feeling sure that a promotion of knowledge among the public generally of the ease and comfort of Gas, in its many uses, will increase the demand, and largely repay the small cost of distribution.

We will print with your imprint, and with such alterations as you may wish, in any quantity at the following rates:

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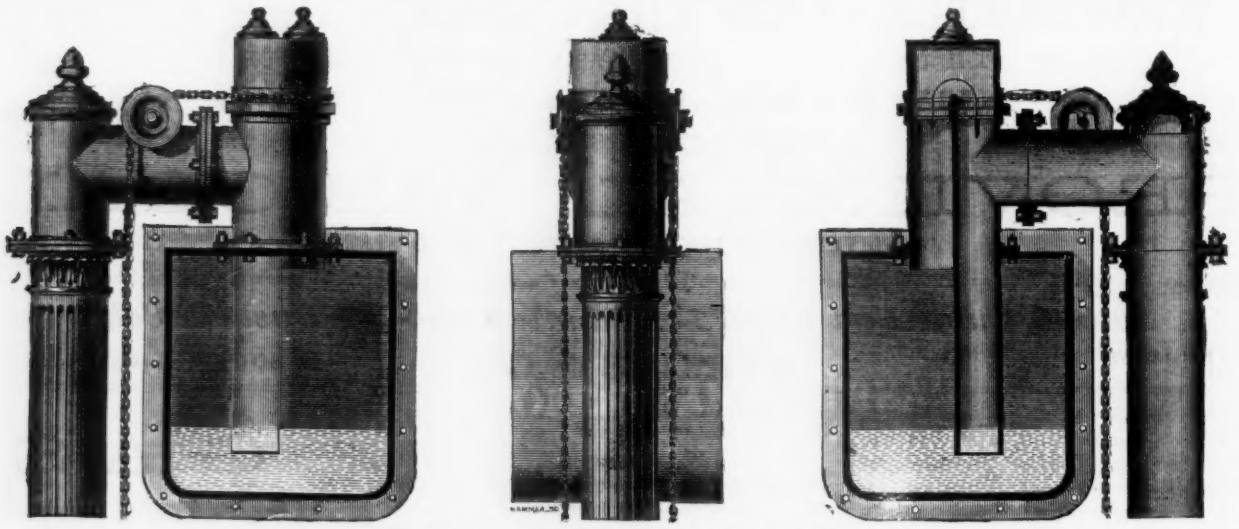

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WILLIAM FARMER may be consulted upon all matters relating to the Manufacture of Illuminating Gas. Will furnish Specifications, Drawings, and Estimates for the Erection of Gas Works of any Capacity, and will erect the same either on Commission or by Contract.

Having made the Construction of Gas Works a Specialty, perfect satisfaction can be guaranteed.

Sole Agent for the FOULIS HYDRAULIC MACHINE for Drawing and Charging Retorts.

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EXHAUSTER (Screw Propeller) for Gas or Air, and Condensation. **DUMPING BARROW** for Wheeling Coal, Coke and Lime, Etc. **HYDRAULIC MAIN** for Reducing Pressure on Retorts. **ZIGZAG SCRUBBERS** for Naphthalizing the Gas and Removing the Tar, Ammonia, and Naphthaline. **BYE-PASS DIP PIPE** for reducing the Pressure on Retorts, Etc., as per cut above. **SELF-ACTING WATER DISTRIBUTOR** for Scrubbers and Washers, Etc. **MOVABLE DIP PIPE** for Reducing and Equalizing the Pressure on Retorts. **TOWER SCRUBBERS** (Jacketted) for Economizing Space and Building Material. **DUPLEX CENTRE SEAL** for Keeping all the Boxes in a set continuously in action.

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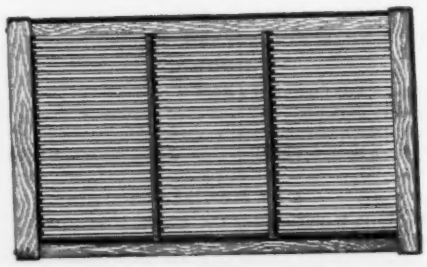

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The book is intended for sale to Gas Companies to distribute gratuitously among consumers. If Gas Companies can induce their consumers to use better burners and shades, one-half of the fault-finding will cease.

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351-1y

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It yields 10,996 cubic feet of gas to the ton of 2,240 lbs. of good illuminating power, and of remarkable purity; one bushel of lime purifying 6,792 cubic feet, with a large amount of coke of good quality.

It has been for many years very extensively used by various Gas Companies in the United States, and we beg to refer to the Manhattan, Metropolitan, and New York Gas Light Companies of New York; the Brooklyn and Citizen's Gas Light Companies of Brooklyn, N. Y.; the Baltimore Gas Light Company of Baltimore, Md., and the Providence Gas Light Company, Providence, R. I.

Best dry coals shipped from Locust Point, wharves, and prompt attention given to orders for chartering of vessels.

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Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine

*** Reference to them is requested. 204-

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Either partner is authorized to sign the name of the firm in liquidation.

NEW YORK, BOSTON. } Aug. 1st. 1878. JAMES D. PERKINS, DANIEL W. JOB.

The business of the late firm of *PERKINS & JOB*, in *NEW YORK*, will be continued by the undersigned under the style of *PERKINS & CO.*

45 South Street, New York, Aug. 1st., 1878. } JAMES D. PERKINS, F. SEAVERNS, JR.

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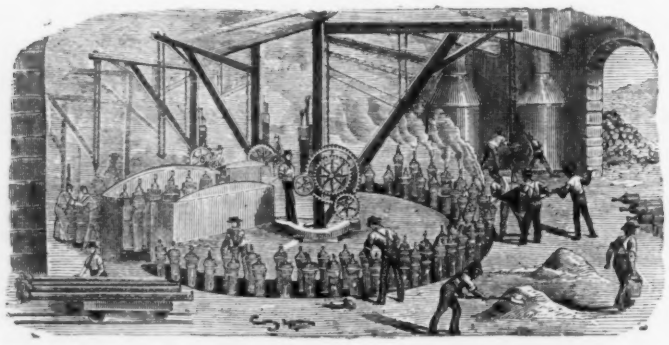

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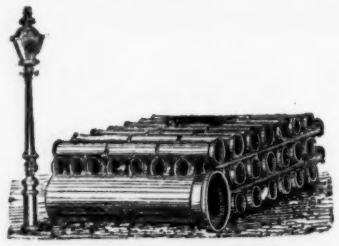

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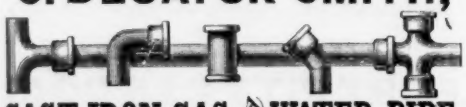

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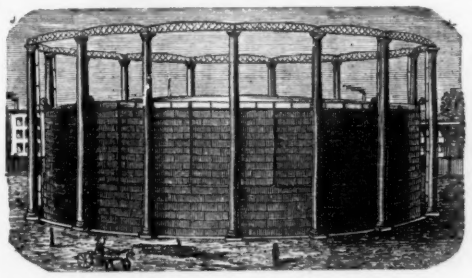

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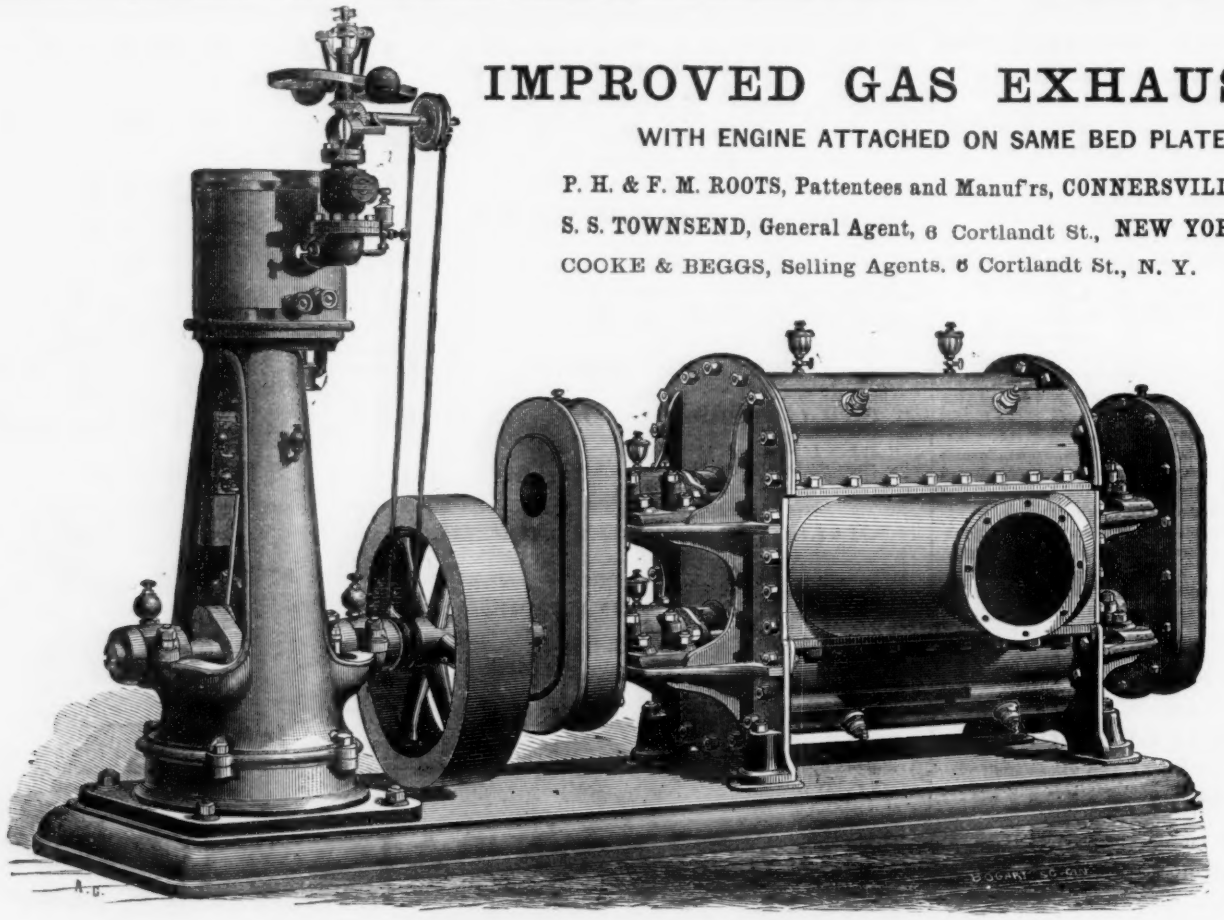

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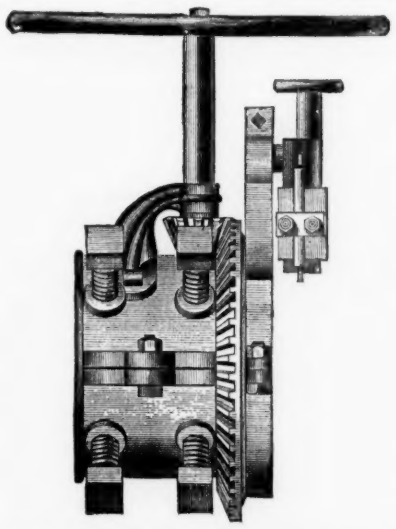

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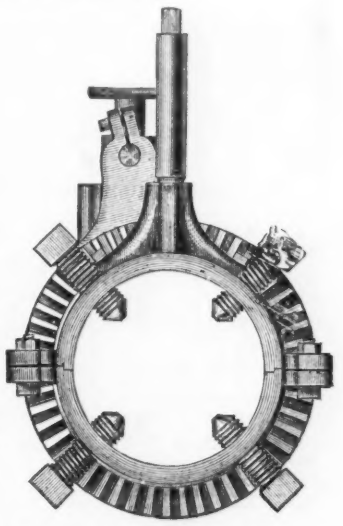

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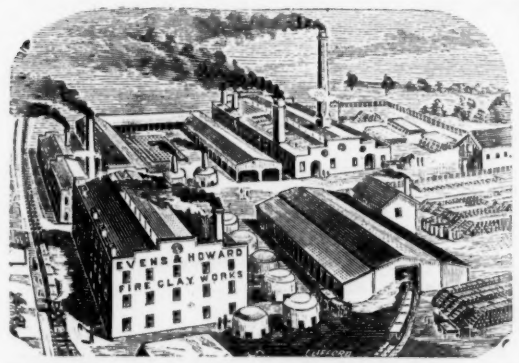

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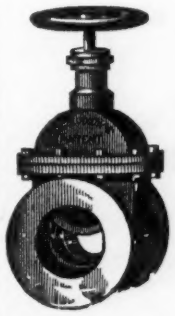

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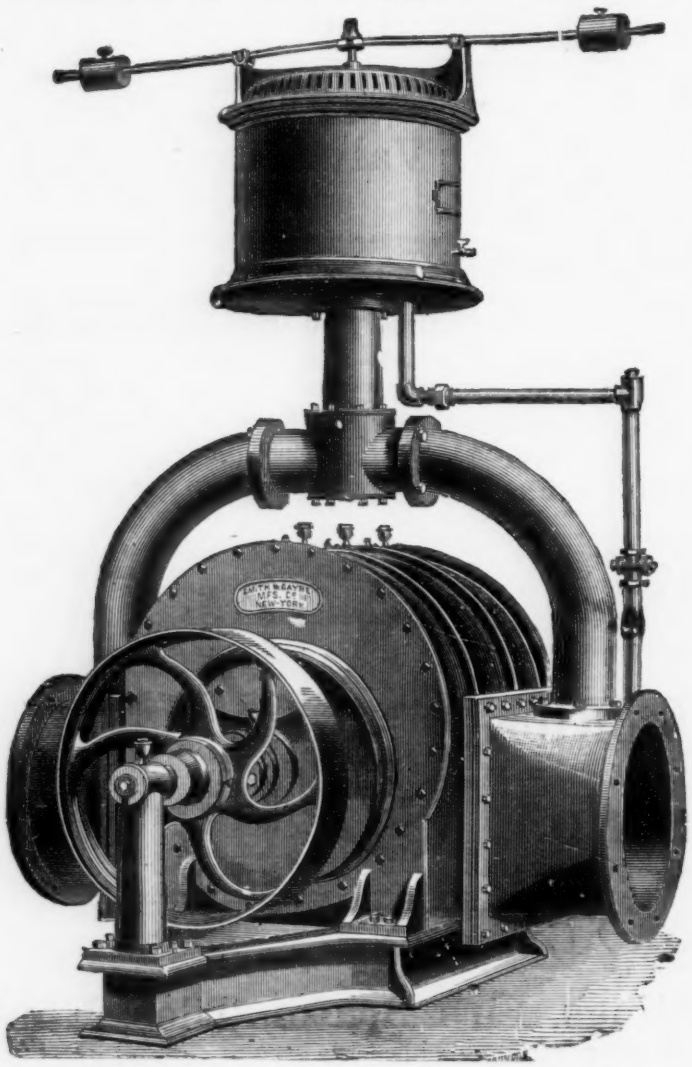

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The Exhibit consists of a series of Articles for the MEASUREMENT of the QUANTITY of Gas, for the ESTIMATION of the ILLUMINATING POWER, and for TESTING its PURITY. The Articles are **RELIABLE** in their indications, and so arranged as to be **READILY APPLICABLE** in **PRACTICE**. They are **ESSENTIAL** to the Public Inspector of City Gas.

J. R. HAWLEY, Pres't.
J. L. CAMPBELL, Secretary.

A. T. GOSHORN,
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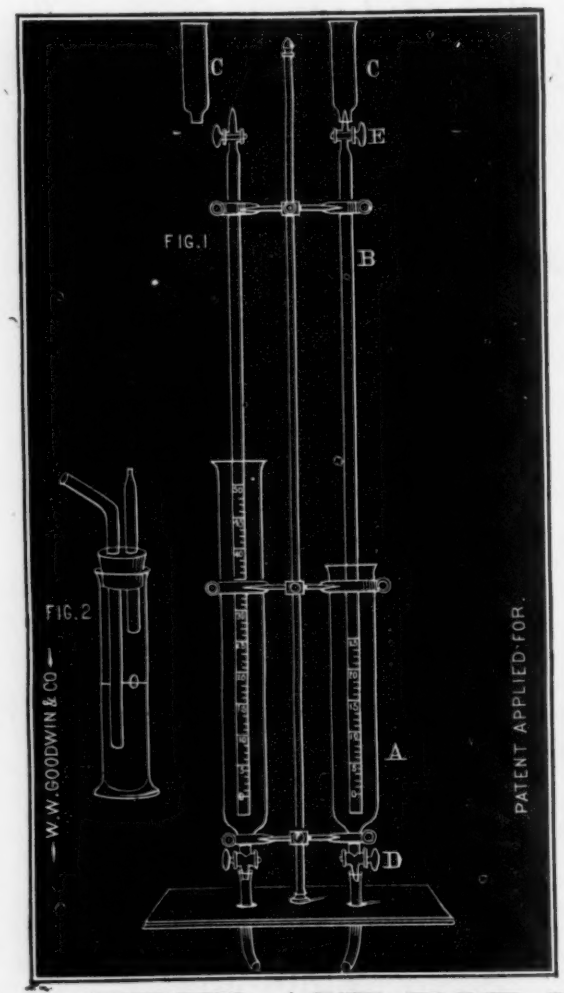
A NEW METHOD FOR THE ANALYSIS OF COAL GAS

The accompanying Cut represents the Apparatus set up.

We now have the pleasure of presenting to Gas Companies a new and easy method for the determination of the constituents contained in coal and other gases. The apparatus is so easy of manipulation, that it will come within the reach of any one.

Although it does not claim to the greatest degree of accuracy, yet with care a satisfactory result may be obtained, and that too, within a very short time; in fact the principal gases only require a few minutes for their separation and determination of quantity.



The apparatus will determine the presence of the following gases, and their quantity:

Ammonia (NH^3)
Sulp. Hydrogen (H^2S)
Carbonic Acid (CO^2)
Air, Oxygen and Nitrogen.
Bisulp. of Carb. (CS^2)
Olefiant Gas (C^2H^4)
Carbonic Oxide (CO)
Light Carburetted Hydrogen (CH^4)
Hydrogen (H)

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